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VAN. H. MANNING, DIRECTOR

A GLOSSARY OF THE MINING AND MINERAL INDUSTRY

BY

ALBERT H. FAY

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A GLOSSARY OF THE MINING AND MINERAL INDUSTRY.

By Albert H. Fay.

INTRODUCTION.

This glossary is published by the Bureau of Mines as a contribution to the mining literature in the belief that it will fill a long-felt need. It contains about 20,000 terms; these include both technical and purely local terms related to metal mining, coal mining, quarrying, petroleum, and natural gas, and metallurgical works; names of useful, important, and common minerals and rocks; and geological terms. It presents in one comprehensive volume the available standard, technical terms relating to the mining and mineral industry, as well as provincialisms that have been or are now in use in English-speaking countries.

The glossary also includes many terms relating to ceramics and the clay industry, glass making, foundry practice, railway and building construction, electrical installation and power-plant equipment, and chemical terms relating to metallurgical practice. Complete lists of terms for each of these allied industries are beyond the scope of this glossary. Paleontological terms, although closely associated with geology, are far removed from mining and metallurgical operations, and for this reason have been omitted.

In a compilation of this magnitude, it is difficult, within a reasonable time to verify all definitions as to the latest usage. Much verifying was done and it is hoped that the best and latest definitions have been used. Reference to the publications cited will enable the reader to determine approximately the period when the definition was used.

Definitions in use by engineers of high national or international reputation are given first preference. When definitions from different sources are the same, credit is given to the earlier author as being the original or nearest to the original source. Immediately following each term the name of the locality wherein the word is presumed to have originated or is widely used is given, where such information is available. The name of the author or source from which the definition was obtained follows the definition, and serves as a key to the publications listed. The terms selected from the various glossaries and publications examined have been compared with the Webster,

the Standard, and the Century dictionaries. A large number of the terms are of purely local usage and do not appear in the dictionaries; these words include many that have been originated and are used by miners and mine inspectors, as well as many others that have been defined by courts, based on testimony given before a jury or judge.

It is difficult to determine when a word is obsolete. It may have been very much in vogue in a certain district, but with the exodus of a particular class or nationality, the use of the term may die out, hence become obsolete so far as that local usage is concerned, although it may continue to be used elsewhere. No attempt, therefore, has been made to eliminate obsolete words, for the engineer doing research work will find such terms, and if he can not determine their meaning from the context he should be able to find them in a glossary or dictionary.

The Spanish and Spanish-American terms were selected as being the most common terms that the engineer will encounter in Latin-American usage.

ACKNOWLEDGMENTS.

In the compilation of this glossary the Bureau of Mines gives credit for each definition as indicated in the list of authors quoted.

The author is indebted to J. W. Thompson, law examiner, Bureau of Mines, for the definitions cited from court cases, compiled by him in connection with his work on the annotation and compilation of Federal and State mining statutes; also to former employees of the Bureau of Mines as follows: Messrs. E. S. Boalich and B. F. Tibbey for selecting words from the text of technical publications, and to Messrs. J. W. Kingsbury and R. H. Seip for comparing the terms with and selecting additional terms from the Standard Dictionary. The Spanish terms were verified by Emilio M. Amores, chief translator for the Pan American Union. The entire list of words defined was compared with the Webster and Century dictionaries by the author.

The galley proof was read by James W. Paul and E. A. Holbrook, mining engineers, Bureau of Mines, for mining terms; by O. P. Hood, chief mechanical engineer, Bureau of Mines, for mechanical terms; by Frank L. Hess and L. La Forge, geologists, U. S. Geological Survey, for terms relating respectively to mineralogy and geology, and much assistance was rendered by M. R. Campbell and E. S. Larsen, U. S. Geological Survey, in scrutinizing terms relating respectively to physiography and petrology; and by David White, F. L. Ransome, and W. C. Alden, U. S. Geological Survey, in checking up certain definitions relating to geology. E. Baliol Scott, editor, and William Head, subeditor, *The Mining Journal*, London, reviewed the galleys for mining and metallurgical terms current in Great Britain. Many additional definitions were thus received and incorporated, certain revisions made, and a large number of suggestions adopted.

AUTHORS QUOTED.

The following is a list of authors quoted as authority for the forms and uses of words given in this glossary:

Quoted in glossary as—	Name of author and publication.
Anderson	Anderson, J. W. The prospector's handbook. 1898. (Includes a glossary.)
Bacon	Bacon, R. F., and Hamor, W. A. American petroleum industry. Vol. 2. 1916. (Includes a glossary.)
Bainbridge	Bainbridge, William. The law of mines and minerals. 5th ed. 1900 (Includes a glossary.)
Barrowman	Barrowman, James. Glossary of Scotch mining terms. 1886.
Bensusan	Bensusan, Arthur J. The Passagem mine and works. Trans., Inst. Min. and Met. London. 1910. Vol. 20, p. 3, et seq.
Bowles	Bowles, Oliver. The technology of marble quarrying. Bull. 106, U. S. Bur. Mines, 1916. Sandstone quarrying in the United States. Bull. 124, U. S. Bur. Mines, 1917. Rock quarrying for cement manufacture. Bull. 160, U. S. Bur. Mines, 1918.
Brunswig	Brunswig, H. Explosives. 1912.
Buckley	Buckley, E. R., and Buehler, H. A. The quarrying industry of Missouri. Missouri Bur. Geol. and Mines. Vol. 2, 2nd ser., 1904. (Includes a glossary.)
Butler	Butler, G. Montague. A pocket handbook of minerals. 1912. (Includes a glossary.)
Century	Century Dictionary and Cyclopedia. 1911.
Chance	Chance, H. M. Report on the mining methods and appliances used in the anthracite coal fields. Second Geol. Survey of Pennsylvania. 1883. (Includes a glossary.)
Chamberlin	Chamberlin, T. C., and Salisbury, R. D. Geology. In three volumes. 1906.
Chester	Chester, A. H. A dictionary of the names of minerals. (Includes history and etymology.) 1st ed. 1896.
Clark	Clark, H. H., and Means, C. M. Suggested safety rules for installing and using electrical equipment in bituminous coal mines. Tech. Paper 138, U. S. Bur. Mines. 1916.
Clennell	Clennell, J. E. The cyanide handbook. 1915.
C. and M. M. P	Coal and metal miners' pocket book. 9th ed. 1904. (Includes a glossary.)
C. M. P	Coal miners' pocket book. 11th ed. 1916. (Includes a glossary of rope terms, p. 262, and a glossary of mining terms, p. 565 et seq.)
Comstock	Comstock, J. L. Elements of geology. 1864. (Includes a glossary.)
Cox	Cox, Herbert. Prospecting for minerals. 1898. (Includes a glossary.)
Crane	Crane, W. R. Ore mining methods. 1910.
Crofutt	Crofutt, George A. Glossary of terms and phrases connected with the mining industry. 1902.
Daddow	Daddow, S. H., and Bannon, Benjamin. Coal, iron, and oil, or The practical American miner. 1866. (Includes a glossary.)
Dale	Dale, T. Nelson. The granites of Vermont. U. S. Geol. Surv. Bull. 404, 1909. (Includes a glossary.)
Daly	Daly, R. A. Igneous rocks and their origin. 1914.
Dana	Dana, E. S. A text book of mineralogy. New ed. 1899; A system of mineralogy. 1914.
Davies	Davies, D. C. A treatise on metalliferous minerals and mining. 1880. (Includes a glossary.)
du Pont	E. I. du Pont de Nemours & Co. High explosives, their manufacture storage, handling and use. 1915. (Includes a glossary of terms used in the explosives industry.)
Duryee	Duryee, S. Nevada prospector's guide. 1906. (Includes a glossary.)
Dwight	Dwight, Arthur S. Glossary of Spanish-American mining and metallurgical terms. Trans. Am. Inst. Min. Eng., vol. 33, 1903.
Egleston	Egleston, Thomas. The metallurgy of silver, gold, and mercury in the United States. 1887. (Includes a glossary.)
Emmons	Emmons, Ebenezer. Manual of geology. 1860. (Includes a glossary.)
Farrell	Farrell, J. H., and Moses, A. J. Practical field geology. 1912 (Includes a glossary.)
Fulton	Fulton, Charles H. The Cyanide process in the Black Hills of South Dakota. Bull. 5 South Dakota School of Mines. 1902.

Quoted in glossary as—	Name of author and publication.
George	George, R. D. Common minerals and rocks, their occurrence and use, Bull. 6, Colorado Geol. Survey, 1913. (Includes a glossary.)
Gillette	Gillette, H. P. Handbook of rock excavation. 1907.
Goesel	Goesel, J. G. Minerals and metals. 1906.
Greene	Greene, Homer. Coal and the coal mines. 1889. (Includes a glossary.)
Greenwell	Greenwell, Allan, and Elsden, J. V. Practical stone quarrying. 1913.
Greenwell, G. C	Greenwell, G. C. A glossary of terms used in the coal trade of Northumberland and Durham. 3d ed. 1888.
Gresley	Gresley, William S. A glossary of terms used in coal mining. 1883.
Halse	Halse, Edward. A dictionary of Spanish, Spanish-American, Portuguese, and Portuguese-American mining, metallurgical and allied terms. 2d ed. 1914.
Hanks	Hanks, Henry G. Second report of the State mineralogist of California from December 1, 1880, to October 1, 1882. (Includes a glossary.)
Hargis	Hargis, A. D. Seventh annual report of the Bureau of Labor, Statistics and Mines of the State of Tennessee, 1897. (Includes a glossary.) Eighth annual report of the Bureau of Labor, Statistics and Mines of the State of Tennessee. 1898. (Includes a glossary.)
Harr	Harr, D. M., and Spruce, M. F. Annual reports of the State inspectors of mines for the first and second districts of the State of West Virginia for the year ended June 30, 1891. (Includes a glossary.)
Hibbard	Hibbard, Henry D. Manufacture and uses of alloy steels, Bull. 100, U. S. Bur. Mines, 1915.
Hitchcock	Hitchcock, Edward. Report on the geology of Vermont. Vol. 2. 1861. (Includes a glossary.)
Hofman	Hofman, H. O. The metallurgy of lead. 6th ed. 1901.
Hooson	Hooson, William. The miners' dictionary. 1747.
Hoover, H. C	Hoover, Herbert C. Principles of mining. 1909.
Hoover, T. J	Hoover, T. J. Concentrating ores by flotation. 3d ed. 1916.
Humble	Humble, William. Dictionary of geology and mineralogy. 1840.
Hunt	Hunt, Robert. British mining, a treatise on the metalliferous mines of the United Kingdom. 1884. (Includes a glossary.)
Iddings	Iddings, J. P. Igneous Rocks. Vol. 1, 1909-13; Rock Minerals, 1911.
Ihlseng	Ihlseng, M. C. A manual of mining. 3d. ed. 1904. (Includes a glossary.)
Ingalls	Ingalls, Walter Renton. The Metallurgy of zinc and cadmium. 1st ed. 1903.
Jackson	Jackson, Charles T. Final report of the geology and mineralogy of the State of New Hampshire. 1844. (Includes a glossary.)
Kemp	Kemp, James Furman. Handbook of rocks. 1904. (Includes a glossary.)
La Forge	Definitions furnished by L. La Forge, geologist, U. S. Geol. Surv.
Lahee	Lahee, F. H. Field geology. 1916.
Lawver	Lawver, W. P. Report of the Director of the Mint. 1883. (Includes a glossary of mining terms.)
Leith	Leith, Charles K. Structural geology. 1913.
Liddell	Liddell, Donald M. The metallurgists' and chemists' handbook. 1916.
Lindgren	Lindgren, Waldemar. Mineral deposits. 1915.
Lock	Lock, Alfred G. Gold, its occurrence and extraction. 1882. (Includes a glossary.)
Lock, C. G. W	Lock, C. G. Warnford. Practical gold mining. 1889.
Lowe	Lowe, E. N. Mississippi, its geology, geography, soils and mineral resources. Bull. 12, Miss. State Geol. Survey, 1915. (Includes a glossary.)
Lucas	Lucas, Frederick. Spanish-English dictionary of mining terms. 1905.
Luquer	Luquer, L. M. Minerals in rock sections. 1908.
McNeil	McNeil, John, State Inspector of Mines. First annual report to the Governor of the State of Colorado for the year ending July 31, 1884. (Includes a glossary.)
Mander	Mander, James. The Derbyshire miners' glossary. 1824.
Megraw	Megraw, Herbert A. The flotation process. 1916.
Meinzer	Meinzer, Oscar E. Glossary of terms pertaining to ground water and related subjects. 1918.
Merrill	Merrill, George P. Stones for building and decoration. 1910. (Includes a glossary.)
Milford	Milford, Philip. Pocket dictionary of mining terms. 1888. (Includes a glossary.)
Miller	Miller, G. W. Field book of practical mineralogy. 1901.
Min. and Sci. Press	Glossary of flotation. *Mining and Scientific Press.* February 12, 1916.

Quoted in glossary as—	Name of author and publication.
Min. Jour.	English and foreign mining glossary. 3d ed. Published by the *Mining Journal*, London. 1871.
Mitzakis	Mitzakis, Marcel. The oil encyclopedia; supplement to the Petroleum World. 1912–1913.
Morine	Morine, A. B. Mining law of Canada. 1909. (Includes a glossary.)
Morrison	Morrison, Robert S. Mining rights. 14th ed. 1910. (Includes a glossary.)
Moses	Moses, A. J., and Parsons, C. L. Mineralogy, crystallography and blowpipe analysis. Revised ed. 1904.
Nat. Tube Co.	National Tube Co. Book of standards. Containing tables and useful information pertaining to tubular goods as manufactured by the National Tube Co. 1915–1916. (Includes a glossary.)
Nicolls	Nicolls, William J. Coal catechism. 1906.
Oldham	Oldham, Thomas. Geological glossary. 1879.
Ore Dep.	Kemp, James Furman. The ore deposits of the United States and Canada. 3rd ed. 1900.
Osborn	Osborn, H. S. Prospector's field-book and guide. 1910. (Includes a glossary.)
Page	Page, David. Handbook of geological terms, geology, and physical geography. 1865.
Perkins	Perkins, George H. Report of the State Geologist on the mineral industries and geology of certain areas of Vermont, 1909–1910 (Includes a glossary of scientific and quarry terms); Report of the State Geologist on the mineral industries and geology of Vermont, 1913–1914. (Includes a glossary of technical terms.)
Peters	Peters, Jr., E. D. Modern copper smelting. 11th ed. 1901.
Pfordte	Pfordte, Otto F. The Cerro de Pasco mining industry. Trans. Amer. Inst. Min. Eng. Vol. 24. 1895.
Pike	Pike Manufacturing Co. Sharpening stones, history and development. 1915. (Includes a glossary.)
Posepny	Posepny, Franz. The genesis of ore deposits. 1901.
Power	Power, F. Danvers. A glossary of terms used in mining geology. Australasian Inst. Min. Eng., 1895; Coal fields and collieries of Australia, 1912 (Includes a glossary.)
Pryce	Pryce, William. Mineralogia cornubiensis, 1778. (Includes a glossary.)
Ralston	Ralston, O. C. Flotation processes for concentrating ores. Press Bull. U. S. Bur. Mines. 1916.
Ransome	Ransome, F. L. The copper deposits of Ray and Miami, Arizona. U. S. Geol. Survey, Prof. Paper 115. (In course of publication.)
Raymond	Raymond, Rossiter W. Glossary. Trans. Amer. Inst. Min. Eng. Vol. 9, 1881.
Redmayne	Redmayne, R. A. S. Colliery working and management. 3rd ed. 1912. (Includes a glossary.)
Redwood	Redwood, B., and Eastlake, A. W. Petroleum technologists' pocket book. 1915.
Richards	Richards, Robert H. Ore dressing. Vols. 1, 2, 3, 4. 1909.
Richardson	Richardson, D. A. Manual of Mexican law. 1910. (Includes a glossary.)
Rickard	Rickard, T. A. A guide to technical writing. 1910. Stamp-milling of gold ores. 2nd ed. 1897. (Includes a glossary of stamp-milling terms.)
	Rickard, T. A., and Ralston, O. C. Flotation. 1917. (Includes a glossary.)
Ricketts	Ricketts, P. de P., and Miller, E. H. Notes on assaying. 1897.
Ries	Ries, Heinrich. Building stones and clay products. 1912. (Includes a glossary.)
Roberts	Roberts, George. An etymological and explanatory dictionary of terms and language of geology. 1839.
Rockwell	Rockwell, John A. Spanish and Mexican law. 1851. (Includes a glossary.)
Rogers, A. F.	Rogers, A. F. Introduction to the study of minerals. 1912.
Rogers	Rogers, W. B. Geology of the Virginias. Virginia Geol. Survey Report, 1840. (Includes a glossary of geological and other scientific terms.)
Roscoe	Roscoe, H. E., and Schorlemmer, C. Treatise on chemistry. 1911. Vol. 1. The nonmetallic elements.
Roy	Roy, Andrew. Ninth annual report of the State inspector of mines for Ohio. 1883. (Includes a glossary.)
Roy. Com.	Report of the Royal commission on mineral resources of Ontario, and measures for their development. 1890. (Includes a glossary of geological and mining terms.)

Quoted in glossary as—	Name of author and publication.
St. John	St. John, Samuel. Elements of geology. 12th ed. 1872. (Includes a glossary.)
Sanders	Sanders, Wilbur E., Parlee, N. W., and MacDonald, Bernard. Mine timbering. 1907.
Shamel	Shamel, Charles H. Mining, mineral and geological law. 1907.
Simms	Simms, Frederick W. Practical tunnelling. 4th ed. 1896. (Includes a glossary.)
Skinner	Skinner, Walter R. The mining manual, 1912 (includes a glossary); The mining manual and mining year book, 1916 (includes a glossary).
kinner (with page reference)	Skinner, Ernest B. The mathematical theory of investment. 1913.
Sloan	Sloan, Earl. Catalogue of the mineral localities of South Carolina. South Carolina Geol. Survey. Ser. 4, Bull. 2. 1908. (Includes a glossary.)
Standard	Standard dictionary, twentieth century edition. 1910.
Steel	Steel, A. A. Coal mining in Arkansas. Geol. Survey of Arkansas. Pt. I. 1910. (Includes a glossary of coal-mining terms.)
Stewart	Stewart, John T. Fourth report of the State inspector of coal mines of Kansas for the year ending Dec. 31, 1890. (Includes a glossary of mining terms.) This glossary was reprinted in the sixth and tenth reports, 1893 and 1897, respectively.
Thompson	Thompson, Maurice. Indiana department of geology and natural history, 15th annual report. 1886. (Includes a glossary.)
Tieman	Tieman, Hugh P. Iron and steel. 1st ed. 1910.
Tucker	Tucker, H. J. Annual report of the State inspector of mines to the Governor of the State of West Virginia for the year ending June 30, 1888. (Includes a glossary.)
U. S. Geol. Surv	United States Geological Survey. Useful minerals of the United States. Bull. 585. 1914.
U. S. Min. Stat	Thompson, Joseph W. United States mining statutes annotated. Bull. 94, U. S. Bur. Mines. 1915.
Ure	Ure, Andrew. A dictionary of arts, manufactures, and mines. 1871.
Vel	Velázquez de la Cadena, Mariano. A new pronouncing dictionary of the Spanish and English languages. 1903.
Vogt	Vogt, J. H. L., Beyschlag, F. H. A., and Krusch, J. P. Ore deposits. 1914–1916.
Watson	Watson, Thomas L., and Ries, Heinrich. Engineering geology. 1915.
Weatherbe	Weatherbe, D'Arcy. Dredging for gold in California. 1st ed. 1907.
Webster	Webster's New International Dictionary of the English Language. 1916.
Weed	Weed, Walter Harvey. The mines handbook and copper handbook. Vol. 12, 1916, and Vol. 13, 1918. (Includes a glossary.)
White	White, Charles A. Report of the geological survey of the State of Iowa. 1870. (Includes a glossary.)
Whitney	Whitney, J. D., and Foster, J. W. Report on the geology and topography of a portion of the Lake Superior land district in the State of Michigan. 1850. (Includes a glossary.)
Willcox	Willcox, F. H. Occupational hazzards at blast-furnace plants and accident prevention. Bull. 140, U. S. Bur. Mines. 1917. (Includes a glossary.) Blast-furnace breakouts, explosions, and slips, and methods of prevention. Bull. 130, U. S. Bur. Mines. 1917. (Includes a glossary.)
Winchell	Winchell, N. H. The iron ores of Minnesota. Geological and natural history survey of Minnesota. Bull. 6. 1891. (Includes a glossary of mining and geological terms.)
Woodson	Woodson, C. C. Fifth annual report of the State mine inspector of the State of Missouri, June 30, 1891. (Includes a glossary of mining terms used in Missouri.)
Worthen	Worthen, A. H. Geology. Vol. 1. Geological survey of Illinois. 1866. (Includes a glossary.)
Young	Young, George J. Nomenclature of mining methods. *Engineering and Mining Journal*. July 22, 1916.

GEOGRAPHICAL ABBREVIATIONS USED.

The accompanying list of abbreviations shows the localities in which certain words are in common use or whence they may have been derived. These abbreviations are used throughout the text.

Arg	Argentina.
Ark	Arkansas, U. S. A.
Aust	Australia.
B. C	British Columbia, Canada.
Belg	Belgium.
Bol	Bolivia.
Braz	Brazil.
Brist	Bristol coal field, England.
Can	Dominion of Canada.
Cent. Am	Central America.
Ches	Cheshire, England.
Clev	Cleveland iron district, England.
Colom	United States of Colombia.
Corn	Cornwall, England.
Cumb	Cumberland coal field, England.
Derb	Derbyshire coal field, England.
Dev	Devonshire, England.
E. Ind	East Indies.
Eng	England.
Forest of Dean	Forest of Dean coal field, England.
Fr	French.
Ger	German.
Gt. Brit	Great Britain.
Glouc	Gloucestershire coal field, England.
Hid	Hidalgo, Mexico.
Hind	Hindustan.
Ill	Illinois, U. S. A.
Ir	Ireland.
It	Italian.
L	Latin.
Lanc	Lancashire coal field, England.
Leic	Leicestershire, England.
Mex	Mexico.
Mid	Midland coal field, England.
Newc	Newcastle coal field, England.
N. S. W	New South Wales, Australia.
N. Z	New Zealand.
No. of Eng	North of England.
No. Staff	North Staffordshire coal field, England.
No. Wales	North Wales, England.
Northumb	Northumberland coal field, England.
Pac	Pacific Coast, U. S. A.
Pat	Patagonia, South America.
Penn	Pennsylvania, U. S. A.
Port	Portuguese (mostly in Brazil).
Prov	Provincial, United States, unless otherwise specified.
Pr	Prussian.
Russ	Russia.
Scot	Scotland.
Shrop	Shropshire, England.
So. Afr	South Africa.
So. Am	South America.
So. Staff	South Staffordshire, England.
So. Wales	South Wales, England.
Som	Somerset, England.
Sp	Spanish origin but not necessarily used in Spain.
Sp. Am	Spanish America.
Staff	Staffordshire, England.
Straits Set	Straits Settlement.
Sw	Swedish.
Trans	Transvaal, South Africa.
U. S	United States of America.
Venez	Venezuela.
W. Afr	West Africa.
War	Warwickshire, England.
Wis	Wisconsin, U. S. A.
York	Yorkshire, England.

A GLOSSARY OF THE MINING AND MINERAL INDUSTRY.

A.

Aa. A Hawaiian word especially introduced into American usage to describe jagged, scoriaceous lava flows. It is contrasted with *pahoehoe.* (Kemp)

Abaco (Mex.). A stone trough used to wash minerals. (Dwight)

Abajador (Mex.). The workman in charge of tools furnished to miners underground. (Dwight). A stable boy in mines. (Vel.)

Abajo! (Mex.). Lower! a signal for lowering a bucket or cage. (Halse)

Abandonment. The act of abandoning; relinquishment. (Webster)
Abandonment of a mining claim may be by failure to perform work; by conveyance; by absence, and by lapse of time. The abandonment of a mining claim is a question of intent. (Richen *v.* Davis, 148 Pacific, p. 1132;—1915.)
To constitute an abandonment of a mining claim, there must be a going away, and a relinquishment of rights, with the intention never to return, and with a voluntary and independent purpose to surrender the location or claim to the next comer. (Peachy *v.* Frisco Gold Mines Co., 204 Federal, p. 668, and Harkrader *v.* Carroll, 76 Federal, p. 475). (Min. Stat., pp. 259–262) *Compare* Forfeiture.

Abate. In metal working, to lower the temper of. (Standard)

Abatis; Abattis (Leic.). Walls or ranges of rough wood, *e. g.*, cordwood placed crossways to keep the underground roads open for ventilation, etc. (Gresley)

Abbé tube mill. A gear-driven tube mill supported on a pair of riding rings and distinguished by an Archimedes spiral, through which the ore is fed and discharged. Grinding is effected by flint pebbles fed into mill. *See* Ball mill. (Liddell)

Abertura de galeria (Sp.). 1. Tunneling; driving. (Lucas)
2. The reopening of a vein. (Halse)

Abigarrado (Mex.). Variegated in color (applied to minerals). (Dwight)

Ablation. 1. The formation of residual deposits by the washing away of loose or soluble minerals. (Kemp)
2. The wearing away of rocks, or the surface melting of glaciers. (Standard)

Abnormal. Not conformable to rule or system; irregular. (Webster)

Abra (Mex.). Open fissure or cavity in the rocks. (Dwight)

Abradant. An abrading substance, as emery, sand, etc., used in grinding and polishing (Standard). *See* Abrasives.

Abrade. 1. To rub or wear off; to waste or wear away by friction, as to abrade rocks. (Webster)
2. As used in the sharpening-stone industry; abrading means cutting, as the steel composing the tool is cut away rather than worn away. (Pike)

Abrasion. 1. The act or process of rubbing or wearing away; as the abrasion of rock or earth by glaciers. 2. The resulting injury or other effects of abrading; an abraided place; as the abrasion left by glacial action. (Standard)

Abrasive. A substance used for abrading, as for grinding and polishing. The principal substances used as abrasives are: Burstone, corundum, emery, garnet, grindstone, infusorial earth, millstone, novaculite, oilstone, pumice, scythestone, tripoli, volcanic ash, and whetstone. Certain furnace products, as carborundum, etc., are also used as abrasives.

Abrevadero (Sp. Am.). A mine, the openings of which are filled with water at the time of working. (Lucas)

Abridura (Mex.). Enlargement of a space, so that miners may work freely (Dwight). A synonym for Abertura.

A GLOSSARY OF THE MINING AND MINERAL INDUSTRY.

A.

[illegible] word especially in- [illegible] American usage to de- [illegible] scoriaceous lava flows. [illegible] with *pahoehoe*. [illegible]

[illegible] A stone trough used to [illegible] (Dwight)

[illegible] The workman in [illegible] furnished to miners [illegible] (Dwight). A stable [illegible] (Vel.)

[illegible] Lower! a signal for [illegible] or cage. (Halse)

[illegible] The act of abandoning; [illegible] (Webster)

[illegible] of a mining claim may [illegible] to perform work; [illegible] by absence, and by [illegible] The abandonment of [illegible] is a question of in- [illegible] Davis, 148 Pacific, [illegible]

[illegible] an abandonment of [illegible] there must be a [illegible] relinquishment of [illegible] never to [illegible] voluntary and [illegible] to surrender [illegible] to the next [illegible] Frisco Gold [illegible] 668, and [illegible] 78 Federal, [illegible] 259-262) [illegible]

[illegible] to lower [illegible]

[illegible] Walls or [illegible] cord- [illegible] the [illegible] tila- [illegible]

Abigarrado (Mex.). Variegated in color (applied to minerals). (Dwight)

Ablation. 1. The formation of residual deposits by the washing away of loose or soluble minerals. (Kemp)
2. The wearing away of rocks or the surface melting of glaciers. (Standard)

Abnormal. Not conformable to rule or system; irregular. (Webster)

Abra (Mex.). Open fissure or cavity in the rocks. (Dwight)

Abradant. An abrading substance, as emery, sand, etc., used in grinding and polishing. (Standard) See Abrasives.

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[illegible]vadero (Sp. Am.). A mine, the [illegible]enings of which are filled with [illegible]ter at the time of working. (Lu[illegible])

[illegible]dura (Mex.). Enlargement of a [illegible]ace, so that miners may work [illegible]ely (Dwight). A synonym for [illegible]ertura.

Abrigo (Mex.). 1. The width of a vein. (Dwight)
2. *A. del carbón* (Peru). An argillaceous rock forming the roof and floor of coal seams. (Halse)

Abrir (Sp.). To drive or open up, as a drift, gallery, tunnel, or to sink, as a shaft. (Halse)

Abronceado; Abronziado (Sp.). Yellow copper ore; sulphides. (Lucas)

Abronzado (Mex.). Chalcopyrite. (Dwight)

Absarokite. A general name given by Iddings to a group of igneous rocks in the Absaroka Range, in the eastern portion of the Yellowstone Park. They have porphyritic texture with phenocrysts of olivine and augite in a groundmass, that is either glassy or contains leucite, orthoclase or plagioclase, one or several. They are chemically, SiO_2, 46–52; Al_2O_3, 9–12; MgO, 8–13; alkalies, 5–6.3, with potash in excess. The name is of greatest significance when taken in connection with shoshonite and banakite. (Kemp)

Absolute atmosphere. An absolute unit of pressure, equal to one million times the pressure produced on a square centimeter by the force of one dyne.

Absolute pressure. That measure of pressure which includes atmospheric pressure. Pressure expressed in absolute measure, commonly in absolute atmospheres (Century). Pressure reckoned from a vacuum.

Absolute temperature. The temperature measured from the absolute zero of temperature on the absolute or thermodynamic scale of temperature. This scale differs slightly from that of an air thermometer, and by the absolute temperature is often meant the temperature on the latter scale above the absolute zero. (Century)

Absolute zero. That point of temperature at which a body would be wholly deprived of heat, and at which a perfect gas would exert no pressure; supposed to be —273° C., —461° F., or —219° Réaumur; used only on the thermodynamic scale. (Standard)

Absorb. To drink in, to suck up, as a liquid by a solid like a sponge or fuller's earth (Rickard). A term used in the flotation process.

Absorbing well. An excavation in the earth through which surface water finds its way to a permeable stratum and is drained away. (Standard). A cesspool.

Absorption. 1. The act or process of absorbing, imbibing, swallowing, or engulfing mechanically. 2. A taking in or reception by molecular or chemical action. (Century)
3. The phenomenon observed when a pleochroic mineral is rotated in plane polarized light. In certain positions the mineral is darker than in others, owing to the absorption of light. (Luquer, p. 26)

Absorption of gases. The action of some solids and liquids in taking up or absorbing gases. (Century)

Abstract. To absorb (the waters of a neighboring stream) by abstraction: said of watercourses. (Standard)

Abstraction. In geology, the withdrawal of a stream from a lower portion of its course by an adjoining stream having more rapid corrosive action. (Standard)

Abstrich (Ger.). The black or greenish-brown mass (black litharge) appearing upon the bath of work-lead early in the cupeling process, and gradually, as the process advances, giving way to pure litharge. (Raymond)

Abtheilung (Ger.). A fixed part or district of a mine assigned to the care of a fireman or deputy. (Gresley)

Abysmal sea. That part of the sea which occupies the ocean basins proper. (Chamberlin, vol. 1, p. 311)

Abyssal rocks. Plutonic, or deep-seated igneous rocks. The word was suggested and has been especially used by W. C. Brögger. (Kemp)

Abzug (Ger.). The first scum appearing (before the *abstrich*) on the surface of molten lead. (Raymond)

Acadialite. A reddish variety of chabazite. (Dana)

Acampanar (Sp.). To remove the overburden down to the surface of the auriferous alluvium. (Lucas)

Acanthite. A silver sulphide, Ag_2S. It contains 87 per cent silver. (U. S. Geol. Surv.)

Acarreador (Mex.). A wood carrier. (Halse)

Acarreo (Sp.). Carriage or conveyance of minerals. (Halse)

Acarreos (Mex.). 1. Float rock. (Dwight)
2. Drift composed of rounded rocks, pebbles and gravel. (Halse)

Accessory minerals. Those mineral constituents of a rock that occur in such small amounts that they are disregarded in its classification and definition. Opposed to essential minerals. (La Forge)

Acción (Mex.). Share in a mine, or other enterprise, usually 100 to the *barra*. Right or ground of action in a suit. (Dwight)

Accionista (Mex.). Shareholder. (Dwight)

Accompt. 1. (Corn.) Account day; the usual settling day. 2. The place of meeting, or account house. (Davies)

Accretion. The process by which inorganic bodies grow larger, by the addition of fresh particles to the outside.

Accretion hypothesis. Any hypothesis of the origin of the earth which assumes that it has grown from a *small* nucleus by the gradual addition of solid bodies, such as meteorites, asteroids, or planetesimals, formerly revolving about the sun in independent orbits, but eventually drawn by gravitation to the earth and incorporated with it. (La Forge)

Aceite (Sp.). Oil, whether of vegetal or mineral origin (Halse). See Petróleo.

Aceitera (Mex.). An oil cup. (Dwight)

Acendrada (Peru). A whitish marl used in making cupelling furnaces. (Halse)

Acendrar (Peru). To refine. (Dwight)

Acequia (Mex.). Canal or ditch. (Dwight)

Acequiero (Sp.). A man in charge of a ditch; a peón who makes a ditch. (Halse)

Acerado (Mex.). Gray copper ore; any gray steely ore. (Dwight)

Aceriate (Fr.). To convert into steel, as by cementation. (Webster)

Acerillo (Peru). Finely crystalline galena showing steely fracture.

Acero (Mex.). Steel; *A. colado*, cast steel. (Dwight)

Acetone. An inflammable liquid (C_3H_6O) with a biting taste, obtained by the destructive distillation of acetates and various organic compounds. It is used in making chloroform and as a solvent for fats, camphor, and resins. (Standard)

Acetylene. The most brilliant illuminating gas (C_2H_2); it may be produced synthetically from its elements by incomplete combustion of coal gas, and commercially from calcium acetylid (CaC_2) (Calcium carbide) by the action of water (Standard). Used much for underground lighting.

Achaparera (Mex.). Long-handled adze. (Dwight)

Achicador; Achichinque (Mex.). Carrier of water. *See also* Achicar. (Dwight)

Achicar (Mex.). To remove water from a mine, generally by carrying it out in bags or buckets. (Dwight)

Achirite. Same as Dioptase. (Standard)

Achroite. A colorless variety of tourmaline. (A. F. Rogers)

Acicular. Needle-shaped; slender, like a needle or bristle, as some leaves or crystals. (Webster)

Acid. 1. Sour, sharp or biting to the taste. Having acid-forming constituents present in excess of the proportion required to form a neutral or normal compound. (Webster)
2. In modern chemistry an acid may be regarded as a salt of hydrogen, or as a compound, containing one or more atoms of hydrogen which may be displaced by a metal, or by a radical possessing to a certain extent metallic functions. (Century)

Acid egg. A cylindrical cistern from which acid is forced by compressed air, as in the manufacture of sulphuric acid. (Webster)

Acidic. A descriptive term applied to those igneous rocks that contain more than 65 per cent SiO_2 as contrasted with intermediate and basic. (La Forge)

Ácido (Sp.). Acid; *A. carbónico*, carbonic acid; *A. negro* (Mex.) in the patio process, spent mother liquor from the crystallizing vats. (Halse)

Acid process. A method of making steel or homogeneous iron in a Bessemer converter or open-hearth furnace having an acid, as opposed to a basic lining. (Standard)

Acid rock. A term rather loosely used in lithology, generally to mean one of the following: 1. An igneous rock containing 60 per cent or more of silica, free or combined, in this sense being nearly equivalent to *acidic.* 2. An igneous rock in which minerals high in silica, such as quartz, alkaline feldspar, and muscovite, are dominant. 3. Very loosely, an igneous rock composed dominantly of light-colored minerals. In all three senses contrasted with *basic.*

The term is misleading and undesirable and is going out of use. As used in the first sense it is being replaced by *silicic* or *persilicic,* and as used in the second sense it should be replaced by *felsic* or by a term denoting the dominant mineral. (La Forge) *See also* Acidic.

Acid salt. A salt in which the replaceable hydrogen of the corresponding acid is only partly exchanged for metallic atoms or basic radicals. (Webster)

Acid steel. Steel manufactured by a process in which the converter or open hearth is lined with siliceous material (Standard). *See also* Acid process.

Acidulae. Cold mineral waters, especially those impregnated with carbonic acid. (Webster)

Acidulous water. Mineral water charged naturally with carbon dioxide (Standard). Also applied to waters containing sulphur compounds, especially sulphates.

Aciérage (Fr.). The process of electroplating a metal with iron or steel. (Standard)

Aciéral. An alloy containing 92 to 97 per cent aluminum and offered as a metal of strength and lightness and noncorrosive, suitable for use in the construction of automobiles, aircraft, military equipment, railroad cars, valves, hardware, etc. It was discovered by M. de Montby. It is suitable for the manufacture of helmets. It is silver white, and has a specific gravity of 2.82 and a melting point of 1,382° F. Its tensile strength in castings is given as 30,000 pounds per square inch, and in rods and sheets as 28,000 to 64,000 pounds and heat-treated as upward of 70,000 pounds per square inch. (Min. and Sci. Press, June 2, 1917)

Acinose. Granulated; like seeds; applied to mineral texture. (Power)

Aclarar (Sp.). To clear the tuyère by passing a pointed bar through the bustle pipe. (Halse)

Aclinic. Having no inclination or dip; situated where the compass needle does not dip, as the aclinic line, or magnetic equator. (Webster)

Acmite. A brown or green silicate of sodium and iron belonging to the pyroxene group. Essentially $NaFe(SiO_3)_2$ (Dana). *See also* Aegirite.

Acmite-trachyte. A trachyte whose pyroxene is acmite or aegirite and whose feldspar is anorthoclase. It therefore differs from normal trachyte in its prevailing soda instead of potash. The acmite-trachytes are intermediate between the true trachytes and the phonolites. They were first described from the Azores and have also been found in the Crazy Mountains, Mont. (Kemp)

Acomodana (Peru). Ore deposits. (Dwight)

Acopios (Sp.). Waste heaps or dumps. (Lucas)

Acquia Creek beds. An obsolete term for Potomac Series.

Acre. 1. A measure of superficial area, usually of land. The statute acre of the United States and England contains 43,560 square feet (4,840 square yards or 160 square rods). The so-called Scotch acre contains about 6,150 square yards and the Irish acre 7,840. There are various special or local acres in England (as in Cheshire or among the hop-growers), varying from 440 to more than 10,000 square yards. (Standard)

2. (Quebec) A linear measure equal to the square root of 43,560, being approximately 208.7 ft.

Acre (Sp.). Sour; acrimonious. (Vel.)

Acreage rent. Royalty or rent paid by the lessee for working and disposing of minerals at the rate of so much per acre. (Gresley)

Acre-foot. The amount of water required to cover 1 acre to a depth of 1 foot; equal to 43,560 cubic feet. Also used in estimating coal in

place; thus a horizontal bed of coal 5 feet thick covering an area of 1 acre would contain 5 acre-feet of coal.

A-cropping (Scot.). Toward the outcrop. (Barrowman)

Acrotomous. In mineralogy, having a cleavage parallel with the base or top. (Standard)

Actinolite. A light-green calcium-magnesium-iron amphibole, $3Mg(Fe)O.CaO.4SiO_2$. (U. S. Geol. Surv.) *See also* Asbestos.

Activar (Mex.). To quicken the chemical reactions in the *torta*. (Dwight)

Actual horsepower. The horsepower really developed, as proved by trial. (Standard)

Actual power. *See* Actual horsepower.

Acueducto (Sp.). Aqueduct; conduit. (Halse)

Acullico (Peru). Resting hour. (Dwight)

Acuñación (Sp.). Coining, as of money. (Min. Jour.)

Acuñador (Sp.). One who coins money. (Crofutt)

Acuñar (Mex.). To coin; to wedge. (Dwight)

Acuoso (Sp.). Watery; aqueous. (Halse)

Acute bisectrix. The line which bisects the acute angle of the optic axes of biaxial minerals. (Dana)

Aczolling. The treatment of timber with a mixture of metallic ammoniates and an antiseptic acid (derivative of phenol or naphthalene). (Liddell)

Adamant. A stone imagined by some to be of impenetrable hardness; a name given to the diamond and other substances of extreme hardness; but in modern mineralogy it has no technical significance. (Webster)

Adamantine. 1. Like a diamond in hardness or luster. 2. Made of, or having the qualities of adamant. 3. Crystallized boron (Webster). 4. A commercial term for chilled steel shot used in well drilling.

Adamantine drill; Shot drill. A core drill employed in rotary drilling in very hard ground. A steel-cylinder bit with a diagonal slot cut in the lower edge is attached to a core barrel and a small quantity of chilled steel shot fed in with the water at intervals. These find their way beneath the bit and wear away the rock as the bit rotates. A core from 4 to 30 inches in diameter is obtained.

Adamantine spar. A variety of corundum, Al_2O_3. (Dana)

Adamellite. A name proposed by Cathrein as a substitute for tonalite, on the ground that tonalite means a hornblende-biotite granite, rich in plagioclase, whereas adamellite, which better describes the rocks at the Tyrolese locality, means a quartz-hornblende-mica-diorite with granitic affinities. Adamellite emphasizes the dioritic characters; tonalite, the granitic. The name is derived from Monte Adamello, near Meran, Tyrol, the locality of tonalite. (Kemp)

Adamic earth (Eng.). A kind of red clay. (Humble)

Adamite. A honey-yellow hydrous zinc arsenate, $Zn_2As_2O_8Zn(OH)_2$, crystallizing in the orthorhombic system. (Dana)

Adamsite. A greenish-black variety of common mica. (Standard)

Adarce. 1. A calcareous sediment of some mineral springs. (Standard) 2. A soft and porous saltish concretion on reeds and grass in marshy grounds in Galatia. (Webster)

Adarme (Peru). A measure of weight equal to 1.8 grams. (Pfordte)

Addle; Adle (No. of Eng.). To earn by labor. (Gresley)

Addling. 1. (No. of Eng.) The act of earning by labor. 2. In the plural that which is earned; earnings. Also written Adlings. (Century)

Adelgazar (Sp.). 1. To thin or rob pillars. 2. To separate gold-bearing concentrate from sand and small stones in order to facilitate the final washing. (Halse)

Adelpholite. A greasy yellow to black iron and manganese columbate that crystallizes in the tetragonal system, and is closely related to tapiolite. (Standard)

Adema, or Ademe. (Sp.). A piece of timber used in supporting mine workings; a prop, shore, or strut. (Halse)

Ademador (Sp.) Mine carpenter, or timberman. (Halse)

Ademar (Mex.). 1. To timber. (Dwight)
2. To make the sides of an artificial drain or ditch. (Halse)

Ademe (Mex.). Timber in mines; timbering in general. (Dwight). *See* Adema.

Adeps petrolei. A form of petrolatum.

Ader wax. Crude ozocerite in leafy masses. (Bacon)

Adhesion. A molecular force by which bodies of matter are caused to stick together. (Rickard). A term used in flotation processes.

Adhesive slate. A very absorbent slate that adheres to the tongue if touched by it. (Standard)

Adinole. A dense felsitic rock composed chiefly of an aggregate of excessively fine quartz and albite crystals, such that on analysis the percentage of soda may reach 10. Actinolite and other minerals are subordinate. Adinoles occur as contact rocks, associated with diabase intrusions and are produced by them from schists (*Compare* Spilosite and Desmite). They also constitute individual beds in metamorphic series (*Compare* Porphyroid, Hälleflinta). The name was first given by Beudant but has been especially revived by Lossen. (Kemp)

Adipocere. A light-colored fatty substance, composed of palmitic and other fatty acids. Not to be confused with the mineral adipocire which is a native paraffin. (Standard)

Adipocerite; Adipocire. A synonym for Hatchettie. (Dana)

A-dipping (Scot.). Toward the dip. (Barrowman)

Adit. 1. A nearly horizontal passage from the surface by which a mine is entered and unwatered. In the United States an adit is usually called a tunnel, though the latter, strictly speaking, passes entirely through a hill and is open at both ends (Raymond). Frequently also called Drift, or Adit level.
2. As used in the Colorado statutes it may apply to a cut either open or under cover, or open in part and under cover in part, dependent on the nature of the ground. (Electro-Magnetic Min. & Dev. Co. *v.* Van Auken, 9 Colo., p. 207; 11 Pacific, p. 80.)

Adit level. *See* Adit.

Adlings. *See* Addling.

Administración (Sp.). Management. (Hanks)

Administrador (Mex.). Manager of a mine. (Dwight)

Adobe. 1. (Sp.). A sun-dried brick; often shortened to *adob* and even *'dobe.* 2. The mixed earth or clay of which such bricks are made. 3. In mining, a brick of pulverized ore mixed with clay, as in quicksilver metallurgy. (Standard)
4. The Mexican silver dollar. *See also* Peso.
5. *See* Mudcap.

Adolescent river. In geology, a river in the second stage of a new drainage system, having a well-cut channel that may reach base-level at its mouth, and a graded bed, and having largely obliterated the lakes and waterfalls of its youthful stage. Its small tributaries may still be in the youthful stage. (Standard)

Adsorb. To condense and hold a gas on the surface of a solid, particularly metals. Also to hold a mineral particle within a liquid interface. From L. *ad,* to, and *sorbeo,* suck in. (Rickard)

Adsorption. The adhesion of the molecules of gases or dissolved substances to the surfaces of solid bodies, resulting in a relatively high concentration of the gas or solution at the place of contact. (Webster)

Adular; adularia. A pure or nearly pure potassium-aluminum silicate; a variety of orthoclase, $KAlSi_3O_8$. (Dana)

Advance workings. Mine workings that are being advanced into the solid, and from which no pillars are being removed.

Advanced gallery. A small heading driven in advance of the main tunnel in tunnel excavation. (Simms)

Adventive crater. A volcanic crater opened on the flank of a great cone. (Daly, p. 144)

Adventure (Corn.). A mining enterprise. (Davies)

Adventurers (Eng.). Shareholders or partners in a mining enterprise; in Cornwall, cost-book partners. (Raymond)

Adverse. To oppose the granting of a patent to a mining claim. (U. S. Min. Stat., pp. 370–385, 548–550, 569–570, 606.)

Advertised out. A term used to express the result of the action of a joint owner of a mining claim who by proper notices causes the interest of his coöwner to be forfeited for failure to perform his share of the assessment work.

Aegirite. *See* Acmite; Wurtzilite. Also written Aegerine.
The name of this soda-pyroxene is often prefixed to normal rock names because of its presence, as for instance, aegirite-granite, aegirite-trachyte. Microscopic study has shown that the mineral is much more widely distributed than was formerly appreciated. (Kemp)

Aeolian. An adjective applied to rocks formed of wind-borne sands. Some such aeolian sands yield large quantities of oil; practically all the big Baku spouters have been obtained from sands of this class. (Mitzakis) *See also* Eolian.

Aeolian rocks. Fragmental rocks, composed of wind-drifted materials. The drift-sand rock, the common building stone of Bermuda, is a good example. (Merrill)

Aeonite. *See* Wurtzilite.

Aérage (Fr.). Ventilation. (Chance)

Aerate. 1. To expose to the action of the air; supply or charge with air. 2. To charge with carbon dioxide or other gas, as soda water. (Standard)

Aerator. 1. An apparatus for charging water with gas under pressure, especially with carbon dioxide. 2. Any contrivance for supplying a stream of air or gas, as for fumigating, destroying fungi, insects, etc. (Standard)

Aerial. Relating to the air or atmosphere. "Subaerial" is applied to phenomena occurring under the atmosphere; "subaqueous" to phenomena occurring under water. (Power)

Aerial railroad. A system of cables from which to suspend cars or buckets, as in transporting or hoisting ore. (Standard) *See also* Aerial tramway.

Aerial spud. A cable for moving and anchoring a dredge.

Aerial tramway. A system for the transportation of material, as ore or rock, in buckets suspended from pulleys or grooved wheels that run on a cable, usually stationary. A moving or traction rope is attached to the buckets and may be operated by either gravity or other power, as determined by topographic features or other conditions.

Aerify. 1. To change into a gaseous form. (Standard)
2. To infuse or force air into; to combine with air. (Webster)

Aerinite. A bright-blue earthy variety of fahlunite.

Aerites. A synonym for Metallites.

Aerogene gas. The gas produced by the system of carbureting air devised by Van Vriesland. This system is installed at Breukelen, Holland, for lighting both streets and houses. (Bacon)

Aerohydrous. Inclosing a liquid in the pores or cavities: said of some minerals. (Standard)

Aerolite. A mass of metallic or other mineral substance which has fallen to the earth through the air. The metallic aerolite consists principally of metallic iron, nickel, and chromium; the nonmetallic aerolite consists of crystalline rocks resembling greenstones; others consist of mixtures of these. A meteorite. (Roy. Com.)

Aerophore. 1. A respirator in the form of a tank which receives the exhalations from the lungs and containing chemicals designed to revive the air, to render it fit for breathing. (Ihlseng)
2. A portable apparatus containing a supply of compressed air for respiration, as for a miner. (Webster)

Aeroplane oil. A white, straight-reduced viscous neutral oil having a gravity of 32¾° to 34° B., a flash-point of 415° F., a fire test of 480° F., a cold test of 20° F., and a viscosity of 185 to 200 Saybolt. (Bacon)

Aerosiderite. A meteorite consisting chiefly of iron, generally nickeliferous, with particles of phosphide of iron, carbon, and hydrocarbons. (Power)

Aerosiderolite. A meteorite that is both metallic and stony. (Standard)

Aerosite. Same as Pyrargyrite. (Standard)

Aerosphere. The atmosphere considered as a spherical shell of gases surrounding the earth. (Standard)

Aerugo. Copper rust; verdigris; especially, green copper coating adhering to old bronzes. (Standard)

Aetite. A nodule consisting of a hard shell of hydrated oxide of iron, within which the yellow oxide becomes progressively softer toward the center, which is sometimes quite empty. (Power)

Affluent. A stream that flows into another; a tributary. (Standard)

Afiladera (Mex.). Whetstone. (Dwight)

Afilar (Mex.). To sharpen (tools). (Dwight)

Afinación (Mex.). 1. Art or process of refining. Refining works. (Dwight) 2. *A. por cristalización*, the Pattinson process. (Halse)

Afinador (Mex.). A refiner (Halse). A synonym for Refinador.

Afinar (Sp.). To refine gold and silver (Halse). A synonym for Refinar.

Afino (Sp.). In tin smelting, melting the ingots in reverberatory furnaces and refining by poling. *A. de cobre*, fusing copper under an oxidizing atmosphere. (Halse)

Aflojadero (Mex.). Soft part of a vein. (Dwight)

Aflojar el canalón (Sp. Am.). To treat the material that has accumulated in the ground sluice, by washing away the lighter and allowing the heavier mineral to settle. (Halse)

Afloramiento (Mex.). Outcrop of vein. (Dwight)

Afrechera (Peru). Finely divided amalgam produced with insufficient mercury. (Dwight)

Afrentar un hilo (Colom.). To make a perpendicular cut in a lode or vein to ascertain its thickness, dip, and strike. (Halse)

À froid (Fr.). In a cold state, *i. e.*, not afterward subjected to the firing process: said of painting and other decoration in ceramics. (Standard)

Afterdamp; Aftergases. The mixture of gases which remain in a mine after a mine fire or an explosion of fire damp. It consists of carbonic acid gas, water vapor (quickly condensed), nitrogen, oxygen, carbon monoxide, and in some cases free hydrogen, but usually consists principally of carbonic acid gas and nitrogen, and is therefore irrespirable. *See also* Black damp.

Aftergases. Gases produced by mine explosions or mine fires.

Agachadero (Mex.). Place in a level where the roof is low. (Dwight)

Against the air. In a direction opposite to that in which the air current moves. To fire shots "against the air," is to fire shots in such an order that the shot firer travels against the air. (Steel)

Agalite. Fibrous talc, pseudomorphous after enstatite. (A. F. Rogers)

Agalmatolite. Essentially a hydrous silicate of aluminum and potassium, corresponding closely to muscovite. A secondary or alteration product. *See also* Pinite (Dana). A soft waxy mineral used for carvings by the Chinese. Also called Lardstone.

Agamasar (Sp.). To make mortar; to cement with mortar. (Halse)

Agaphite. A conchoidal variety of Persian turquoise. (Standard)

Agaric mineral. 1. A soft, light, pulverulent hydrated silicate of magnesium found in Tuscany, from which floating bricks can be made. (Power) 2. A light, chalky deposit of calcium carbonate, sometimes called rock milk, formed in caverns or fissures of limestone. (Webster)

Agate. A variegated waxy quartz in which the colors are in bands, in clouds, or in distinct groups; also, a gem or precious stone made from this mineral. (Standard) A variegated chalcedony.

Agate jasper. An agate consisting of jasper containing veinings of chalcedony. (Dana)

Agate opal. Opalized agate.

Agate ware. 1. An enameled iron or steel ware used for household utensils. Used extensively as table equipment in miners' camps and boarding houses. 2. Pottery, veined and mottled to resemble agate. (Standard)

Agatized wood. *See* Wood, 2.

Age. 1. Any great period of time in the history of the earth or the material universe marked by special phases of physical conditions or organic development; an eon; as the age of mammals. Called also Era. 2. One of the minor subdivisions of geological time, a subdivision of the epoch corresponding to stage or formation; recommended by the International Geological Congress. (Standard)

Aged. Approaching base-level. Formerly used in topography, geology, and physiography, and applied to the configuration of ground. (Standard)

Agent (Eng.). One to whom the general laying out and supervision of the mine is intrusted by the owner or lessee. *See also* Viewer (Gresley). The manager of a mining property.

Agente (Mex.). Agent; *A. de minería*, a mining agent appointed by the government in each district to receive documents, give possession, etc.; *A. de correos*, a postmaster. (Halse)

Agglomerate. 1. A breccia composed largely or wholly of fragments of volcanic rocks. More specifically, a heterogeneous mixture of fragments of volcanic and other rocks filling the funnel or throat of an extinct or quiescent volcano. (La Forge)
2. To wind or collect into a ball; hence to gather into a mass; to cluster. (Webster)

Aggradation. 1. In geology, the natural filling up of the bed of a watercourse by deposition of sediment. 2. Specifically, the building up by streams in arid regions of fan-like graded plains, by reason of the shifting streams and the loss of the water in the dry soil. Contrasted with Degradation. (Standard)

Aggradation plain. A plain formed by aggradation in arid districts. It begins by the building up of the hollowed bed of a stream, at the foot of a declivity, forming a plain with a nearly straight longitudinal profile, that may become a very broad plain of deposition. (Standard)

Aggregate. 1. To bring together; to collect or unite into a mass. 2. Composed of a mixture of substances, separable by mechanical means. (Webster)
3. The mineral material, such as sand, gravel, shells, slag, or broken stone, or combinations thereof, with which cement or bituminous material is mixed to form a mortar or concrete. "Fine aggregate" may be considered as the material that will pass a ¼-inch screen, and "coarse aggregate" as the material that will not pass a ¼-inch screen. (Bacon)

Aggregate polarization. The polarization displayed by extremely small grains of doubly refracting minerals. (Dana)

Aggregate structure. A confused mass of separate little crystals, scales, or grains all extinguished under the polarizing microscope at different times. (Luquer)

Agitation. In metallurgy, the act or state of being shaken, stirred, or moved with violence.

Agitation ratio. The ratio between the maximum diameter of a gangue particle and the diameter of the mineral particle that travels with it on a vanner. (Richards, p. 665)

Agitator. 1. An implement or apparatus for shaking or mixing. (Webster)
2. A mechanical apparatus employed in refining petroleum to keep the oil in constant motion when it is treated with sulphuric acid. Agitation on a large scale is now performed by means of compressed air. (Mitzakis)
3. (Pac.) *See* Settler.
4. A vat in which ore pulp is maintained in constant movement by compressed air, or mechanical means.

Agnesite (Corn.). An early name for bismutite.

Agonic line. A line passing through points on the earth's surface at which the direction of the magnetic needle is truly north and south; a line of no magnetic declination. (Standard)

Agricolite. An adamantine colorless or yellow bismuth silicate. $Bi_4Si_3O_{12}$, crystallizing in the monoclinic system. (Dana)

Agrimensor (Mex.). Surveyor. (Dwight)

Agua (Sp.). Water. *A. arrimanda* (Colom.), water brought along the side of a ravine to be used in mining. *A. de alimentación*, feed water for a steam engine. *A. de cantera*, natural moisture in stones. *A. delgada*, water containing a small quantity of salts in solution. *A. dulce*, fresh water. *A. gorda*, water containing a large quantity of salts in solution. *A. llovediza*, rain water. *A. potable*, drinking water. *A. fuerte*, nitric acid. (Halse)

Aguador (Sp.). One in charge of the water supply of a mill. (Halse)

Agua fuerte (Sp.). Nitric acid. (Halse)

Aguas de cabeza (Peru). Water filtering into the mine, due to rain. (Halse)

Aguilarite. A sectile silver selenide, $Ag_2S.Ag_2Se$ occurring in skeleton dodecahedral crystals. (Dana)

Aguja (Sp.). 1. (Colom.) A leader or narrow vein. A branch. (Lucas) 2. A mountain peak. 3. A compass needle. 4. A blasting needle. 5. A switch rail. (Halse)

Aguja magnética (Mex.). Magnetic needle. (Dwight)

Agujero (Mex.). Drill hole. (Dwight)

Agujón (Mex.). Surveying instrument with compass. (Dwight)

Agulhas (Braz.). Oxides of titanium associated with diamonds. (Halse)

Aguzar (Mex.). To sharpen (drills). (Dwight)

Ahogarse. To pinch out, as a vein. (Lucas)

Ahogarse el oro (Colom.). To lose gold by its being carried off by the water. (Lucas)

Ahondar (Sp.). To sink; to deepen. (Min. Jour.)

Ahonde (Mex.). A shaft to establish mining title (Dwight). A discovery shaft.

Aich's metal. *See* Gun metal.

Aiguille (Fr.). 1. A very sharp peak; used especially of certain peaks, or clusters of needle-like rocks near Mont Blanc. 2. An instrument for boring holes, used in blasting. (Webster)

Aikinite. A blackish lead-gray sulphide of lead, copper, and bismuth, $3(Pb, Cu_2)S.Bi_2S_3$, that crystallizes in the orthorhombic system; needle ore. (Dana)

Ailsyte. A name derived from Ailsa Craig, Scotland, and suggested for a microgranite containing considerable riebeckite. (Kemp)

Ainalite. A variety of cassiterite containing tantalum pentoxide. (Standard)

Air. 1. The mixture of gases that surrounds the earth and forms its atmosphere; composed by volume of 21 parts of oxygen and 78 of nitrogen; by weight of about 23 parts of oxygen and 77 of nitrogen. It contains also about 0.03 per cent of carbon dioxide, some aqueous vapor, and about 1 per cent argon. (Century) 2. The current of atmospheric air circulating through and ventilating the workings of a mine. 3. To ventilate any portion of the workings. (Gresley)

Air adit. An adit driven for the purpose of ventilating a mine. (Milford)

Air blast. 1. A disturbance in mines accompanied by a strong rush of air through the workings. It is caused by the falling of large masses of roof in stopes, or by sudden crumbling of pillars under the weight of the rock above the mine workings, due to a stress on the rocks, which has produced a strain, and in mining operations this strain results in a violent rupture. Such a disturbance is sometimes called "quake," and the rock, "explosive rock." (Eng. and Min. Jour., vol. 105, p. 957) 2. A stream or current of air under pressure, especially that used in forges and furnaces. (Century)

Air box. 1. A rectangular wooden pipe or tube made in lengths of, say, 9 to 15 feet for ventilating a heading or a sinking shaft. (Gresley) 2. A box for holding air. 3. A flue for conducting air to a furnace, etc. (Webster)

Air brick. A hollow or pierced brick built into a wall to allow the passage of air. (Ries)

Air bridge. 1. A furnace bridge so constructed as to admit heated air to the gases passing over it and thus facilitate their combustion. (Century) 2. *See* Overcast.

Air cock. A cock for letting off air. (Barrowman)

Air compartment. An air-tight portion of any shaft, winze, raise, or level, used for ventilation. (C. and M. M. P.)

Air compressor. A machine for compressing air to a pressure sufficient to actuate machinery. (Weed)

Air condenser. A surface condenser cooled by contact with air instead of water. (Webster)

Air course. A passage through which air is circulated. Particularly a long passageway driven parallel to the workings to carry the air current. *Entry air course*, a passage for air parallel to an entry. *Slope air course*, an air course parallel with a slope. (Steel)

Air crossing. A bridge or overcast where one current of air passes another without coming in contact with it. (Roy)

Air cushion. An air-tight inflatable cushion; also a device for arresting motion without shock, by confined air. (Webster)

Air door. A door placed in a mine passage to prevent the air from taking a near way to the outcast, or return, without making a circuit of the workings. (Tucker)

Air drain. A passage for the escape of gases from a mold while the molten metal is being poured in. (Standard)

Air drift. A drift connecting a ventilation shaft with the fan. (Power)

Air drill. A rock drill driven by compressed air, as distinguished from a drill driven by steam. (Century)

Air dry. Dry to such a degree that no further moisture is given up on exposure to the air. Most air-dry substances contain moisture that can be expelled by heating them or placing them in a vacuum. (Webster)

Air duct. *See* Air box, 1 and 3.

Aire (Sp.). 1. Air or wind. 2. Fire damp, explosive or inflammable air. 3. Foul air. (Halse)

Air-end way (Eng.). Roadways or levels in the coal seam driven parallel with a main level, chiefly for return air in mine ventilation. (Gresley)

Air furnace. 1. A furnace that depends on natural draft and not on blast. A furnace for heating air. (Webster)
2. A reverberatory furnace in which to smelt lead. Also a reverberatory melting furnace used in the manufacture of malleable cast iron.

Air gas. A combustible gas made by saturating air with the vapor of some volatile hydrocarbon mixture, as gasoline, and used for lighting and heating. (Webster)

Air gate. 1. (Mid.) An underground roadway used principally for ventilation. (Gresley)
2. An air regulator. 3. In molding, an orifice through which the displaced air and gases escape from the mold while the molten matter is filling it. (Century)

Air hammer. A pneumatic hammer.

Air head, or Air heading. (So. Staff.) A smaller passage, driven parallel with the gate road and near its roof, to carry the ventilating current. It is connected with the gate road at intervals by openings called spouts (Raymond). *See also* Airway.

Air hoist. Hoisting machinery operated by compressed air. (Century)

Air hole. 1. A hole drilled in advance to improve ventilation by communication with other workings or with the surface. (C. and M. M. P.)
2. A flaw in a casting. (Standard)

Air jig. An apparatus for separating ores without water, by intermittent puffs of air. (Lawver)

Airless end. The extremity of a stall in long-wall workings in which there is no current of air. The air is kept sufficiently pure by diffusion, and by the ingress and egress of tubs, men, etc. (Gresley)

Air level (Eng.). A level or airway (return airway) of former workings made use of in subsequent deeper mining operations for ventilation. (Gresley)

Air lift. An arrangement for raising water or other liquid from a well or sump, air under pressure being introduced near the foot of an open-ended pipe having a certain submergence. The column of liquid or mixture of solid and liquid in the pipe, because of the introduction of the air, is made lighter than the submergence column outside and an upward flow within the pipe results.

Air lock. 1. (Aust.) A passage, closed at both ends by doors, between airways along which currents of different pressures are flowing. Persons desirous of passing from one airway to the other can do so without personal inconvenience or interference with the system of ventilation. (Power)
2. An air chamber between the outer air and the working chamber of a pneumatic caisson. (Webster)

Air machine. A machine for forcing fresh air into and withdrawing bad air from a mine, as a fan. (Hanks)

Air man. A synonym for Brattice man.

Air motor. A motor driven by compressed air. (Webster)

Airometer. An instrument for measuring the rate of flow of air; an air meter. (Webster)

Air oven. A heated chamber for drying samples of ore, etc. (C. and M. M. P.)

Air pipes. Pipes for conveying air for ventilation or for other purposes. (Hanks)

Air pit (Eng.). A mine shaft used expressly for ventilation. (Gresley)

Air propeller. A device, as a rotary fan for circulating air, as for ventilation. (Webster)

Air pump. A pump for exhausting air from a vessel or closed space. Also a pump for compressing air. (Webster)

Air receiver. A strong vessel, into which air from a compressor is delivered. It serves as a reservoir to equalize the pressure before the air is used. It also cools the air, collects moisture, which may be drawn off, and eliminates the pulsating effect of the piston strokes.

Air-reduction process. *See* Roasting and reaction process.

Air saddle. (Aust.). A surface saddle or depression produced by erosion at the top of an anticline.

Air shaft. A shaft used for ventilating mines; it may either receive or discharge the circulating current. (Roy). *See* Upcast, *also* Downcast.

Air shot. A shot prepared by loading (charging) in such a way an air space is purposely left in contact with the explosive for the purpose of lessening its shattering effect. (Du Pont)

Air shrinkage. The decrease in volume which a clay undergoes in drying. (Ries)

Air-slaked. Slaked by exposure to the air; as air-slaked lime. (Webster)

Air slit (York.). A short heading driven more or less at right angles to and between two headings or levels for ventilation. (Gresley)

Air sollar. A compartment or passage way carried beneath the floor of a heading or of an excavation in a coal mine for ventilation. (Century). *See also* Sollar.

Air split. The division of the main current of air in a mine into two or more parts. (Roy)

Air stack (Penn.). A chimney used for ventilating a coal mine. (Century)

Air trap. A trap for shutting off or carrying off foul air or gas from drains, sewers, etc. (Webster)

Air trunk. A large pipe or shaft for conducting air, as for ventilation, or to a furnace. (Webster)

Air tub. The cylinder on a blowing engine that pumps the blast of wind or air. (Willcox)

Air valve. A valve to regulate the ingress or egress of air. (Webster)

Air vessel. A chamber connected with a pump and partly filled with air to regulate the flow of water and lessen shocks (Barrowman). Also an air receiver.

Air volcano. A miniature crater resembling a true volcano in shape and often provided with a cone; produced by explosions of gas and the emission of mud. (Century)

Airway. Any underground gallery or passage through which a portion of the ventilation passes. (Gresley)

Airy's spiral. A four-rayed spiral curve, named after the discoverer and shown when sections of right-handed and left-handed crystals are placed together in a polariscope. (Dana)

Aitch-piece. *See* H-piece.

Aixtrie (Scot.). An axle. (Barrowman)

Ajkite. A resin related to succinite, from Ajka, Hungary. *See also* Succinite. (Bacon)

Ajuste (Sp.). 1. Contract. 2. Adjustment (of parts of a machine). (Dwight)
3. A timber joint or connection made by notching or scarfing. (Halse)

Akerite. A variety of syenite, consisting of orthoclase, considerable plagioclase, biotite, augite, and some quartz. (Kemp)

Akins' classifier. A classifier consisting of an interrupted-flight screw conveyor, operating in an inclined trough.

Alabandite. Manganblende. Manganese sulphide, MnS. (Dana)

Alabaster. Compact fine-grained gypsum, white or delicately shaded. *See also* Gypsum. (U. S. Geol. Surv.)

Alabasterine. Of, pertaining to, or like, alabaster. (Webster)

Alabastro (Sp.). Alabaster. (Min. Jour.)

Alacrán (Mex.). A wheel or pair of wheels sometimes used in turning (stirring) the ore in the patio process. (Halse)

Ala de Mosca (Peru). Granite or very hard rock. (Dwight)

Alajites (Mex.). Altered rhodonite. (Dwight)

Alalite. A light-green variety of diopside from the Ala Valley, Tyrol. (Webster)

Alambre (Sp.) Wire of any metal. (Vel.)

Alandier (Fr.). In ceramics, a special fireplace at the base of a porcelain kiln, fed from the outside. (Standard)

Alarife (Sp.). Mine mason. (Dwight)

Alaskite. Any igneous rock consisting essentially of quartz and alkalic feldspar, without regard to texture.

Albañil (Sp.) A mason; a bricklayer. (Halse)

Albañilería (Sp.). Walling of masonry. (Halse)

Albáni stone (L.). The *peperino* of the Italians; a well-known volcanic rock, much used at Rome before building with marble became common. *See* Peperino. (Page)

Albarium (L.). White lime used for stucco and obtained by burning marble. (Standard)

Albarradón (Sp.). A dike. (Halse)

Albata (L.). A white alloy resembling German silver, consisting of nickel, copper, and zinc. (Standard)

Albayalde (Mex.). White lead, lead carbonate. (Vel.)

Albert coal; Albertite (Eng.) An asphaltic mineral occurring at Hillsboro, New Brunswick. It fills a fissure that cuts the associated strata almost vertically, and is from 1 to 16 feet thick.

Alberti furnace. A continuously working reverberatory furnace for the roasting of quicksilver ores, with condensation of the mercury in iron tubes and brick chambers. (Raymond)

Albertite. A jet-black, pitchlike, brittle hydrocarbon with conchoidal fracture, differing from ordinary asphalt in being only partly (about 30 per cent) soluble in turpentine and in very imperfect fusion when heated (U. S. Geol. Surv.). Also called Albert coal in Nova Scotia.

Albion metal (Eng.). A combination made by overlaying lead with tin and causing the two to adhere by passing them under pressure, between rollers. (Century)

Albirupean. An obsolete geological term for Potomac series.

Albite. An end member of the plagioclase series of feldspars, containing no calcium and consisting of sodium-aluminum silicate; sodium feldspar. Less common than the intermediate members, which may be considered as mixtures of albite with the other end member, anorthite (Ransome). *Compare* Anorthite.

Albite law. A mode of twinning in which the twinning plane is the brachypinacoid. It is common with the mineral albite, and gives rise to the fine striations on its cleavage surface. (Webster)

Albitization. The production, in a rock, of albite as a secondary mineral. (Webster)

Albitophyre. A dike rock containing large polysynthetic phenocrysts of albite. In the groundmass are microlites of the same mineral, together with chlorite and limonite. (Kemp)

Albo-carbon. A solid residuum of creosote. (Century)

Albolite; Albolith. A kind of plastic cement, or artificial stone, consisting chiefly of magnesia and silica. (Webster)

Alboranite. A variety of hypersthene-andesite, poor in soda, from the island of Alboran, east of the Straits of Gibraltar. (Kemp)

Albrecht condenser. A condenser used in petroleum distillation, to separate the distillate into its various fractions. (Mitzakis)

Albrecht viscometer. *See* Viscometer.

Albronz. A durable alloy of copper and aluminum, used for telescope bearings, etc. (Standard)

Alcalde (Sp.). 1. A justice of the peace. 2. A city mayor. (Halse)

Álcali (Sp.). Alkali. (Vel.)

Alcance; Saldo (Sp.). 1. Balance due. (Dwight)
2. Extent of underground workings.
3. (Chile) A rich zone of ore. (Halse)

Alcancia (Mex.). A loading chute. (Dwight)

Alcantarillado; Alcantarilla (Sp.). An underground aqueduct, drain, or tunnel. (Vel.)

Alcaparrosa (Mex.). Efflorescence (of sulphates, etc.) in old workings (Dwight). *See also* Caparrosa.

Alcarraza (Mex.). A water can used in drilling. (Dwight)

Alcatruz (Port.). A bucket of a dredge. (Halse)

Alchemy. 1. The immature chemistry of the Middle Ages, characterized by the pursuit of the transmutation of base metals into gold, and the search for the alkahest and the panacea. (Standard)
2. To coat or alloy with another metal.

Alchymy (Scot.). A white film, usually calcium carbonate, in joints of coal, iron-stone, and other minerals (Barrowman). Probably from alchemy, to coat or alloy with another metal. Now obsolete.

Alcove. A large, deep niche formed by a stream of water in a precipitous face of approximately horizontal strata. (Standard)

Alcribis (Mex.). A tuyere. *See also* Tobera. (Dwight)

Aleación (Sp.). 1. The art of alloying metals. 2. An alloy. (Halse)

Alear (Sp.). To alloy. (Vel.)

Alembic. An apparatus formerly much used in distilling. Usually made of glass or metal. (Webster)

Alembroth. The chloride of ammonium and mercury. Formerly used as a stimulant. The alchemist's "salt of wisdom." (Webster)

Aleutite. A name proposed by J. E. Spurr for those members of his belugites (*which see*) having a porphyritic texture with an asphanitic or finely crystalline groundmass. (Kemp.)

Alexandrite. An emerald-green variety of chrysoberyl, columbine-red by transmitted light. (Standard)

Alexjejevite. A resin from the Kaluga province, Russia. (Bacon)

Alfenid. A nickel alloy electroplated with silver. (Standard)

Alfileres de oro (Colom.). Gold in needle-shaped filaments. (Lucas)

Algam. In Wales, a common term for tin.

Algonkian; Proterozoic. In the nomenclature of the United States Geological Survey, the second in order of age of the systems into which the stratified rocks of the earth's crust are divided; also the corresponding period of geologic time. Some authorities use Proterozoic in the same sense. (La Forge)

Algovite. A name proposed by Winkler for a group of rocks, practically diabases or porphyritic phases of them, in the Algäuer Alps. They also embrace gabbros, according to Roth, and are doubtless textural varieties of an augite-plagioclase magma. (Kemp)

Alidade. 1. An auxiliary circle, frame, or movable arm, carrying microscopes or verniers for reading the divisions of a graduated circle or arc; also a theodolite having such an arm. 2. The straight-edge carrying the telescope for plane-table observations. (Standard)

Alien locator. A foreigner who locates a mining claim on the public domain. (U. S. Min. Stat., p. 101)

Alignment; Alinement. 1. The act of laying out or regulating by line; an adjusting to a line. 2. The line of adjustments. 3. The ground plan of a railway or other road in distinction from profile. (Century)

Alimentador (Sp.). Ore feeder of a stamp battery; *A. mecánico*, an automatic feeder; *A. de un horno*, a furnace charger; *A. de la caldera*, a boiler feeder. (Halse)

Alimentar (Sp.). To feed a mill, etc.; *A. un horno*, to charge a furnace. (Halse)

Alimento (Sp. Am.). An allowance as subsistence; a kind of 'grubstake' to miners until their mines become profitable. (Crofutt)

Alipite. A massive apple-green hydrated magnesium-nickel silicate similar to genthite. (Standard)

Alipús (Mex.). A gad. (Dwight)

Alive (Corn.). The productive part of a lode. (Power)

Alizarin. A dyestuff, $C_{14}H_6O_2(OH)_2$, formerly prepared from madder, and now produced artificially from anthracene, and forming when pure a reddish-yellow powder or orange-red crystals. (Webster)

Alkahest. In alchemy, an imaginary liquid, reputed to be a universal solvent, capable of resolving all bodies into their constituent elements. (Standard)

Alkali. In chemistry, any substance having marked basic properties. In its restricted and common sense the term is applied only to hydroxides of potassium, sodium, lithium, and ammonium. They are soluble in water, have the power of neutralizing acids and forming salts with them, the property of corroding organic substances, and of turning red litmus blue. In a more general sense the term is applied to the hydroxides of the so-called alkaline-earth metals: barium, strontium and calcium.

Alkali flat. A sterile plain, containing an excess of alkali, at the bottom of an undrained basin in an arid region. A *playa*. (Webster)

Alkali metal. Any metal of the alkali group, as lithium, sodium, potassium, rubidium, or caesium. (Webster)

Alkalimeter. An instrument to ascertain the strength of alkalies, or the quantity of an alkali in a mixture. (Webster)

Alkaline. 1. Applied to minerals having the taste of soda. (Dana)
2. Of or pertaining to the properties of an alkali. (Webster)

Alkaline earths. The oxides of barium, calcium, and strontium. Some include also magnesium oxide. All are in their properties intermediate between the true alkalies and the earths proper. (Webster)

Alkaline metals. Those metals whose oxides combine with water to form alkalies, as lithium, sodium, and potassium, etc. (Standard)

Alkali test. A process by which kerosene is treated with a solution of caustic soda, making it purer and more suitable for illuminating. The kerosenes are divided into classes according to the results given by this alkali test and a fixed scale constructed. (Mitzakis)

Alkali wash. In the cyanide process, a preliminary treatment of the pulp with an alkaline solution, commonly of lime, the chief object being to secure the neutralization of free acid before adding the strong cyanide solution, thus avoiding the undue consumption of cyanide.

Alkali waste. Waste material from the manufacture of alkali; as soda waste in the Leblanc process. (Webster)

Alkinite. A compound of lead, copper, bismuth, and sulphur, occurring in lead-gray, needle-shaped crystals, and also massive. (Webster)

Allagite. A heavy dull red or green altered carbonated rhodonite. (Dana)

Allalinite. A name derived from Allalin Mountain in the Pennine Alps, and applied by H. Rosenbusch to an actinolite-saussurite rock derived from gabbro without losing the characteristic texture of the latter. That is, the allalinites are not sheared and crushed as in the flasergabbros and forellensteins. (Kemp)

Allanite; Orthite. 1. A complex variable silicate of aluminum, iron, the cerium metals, and, in smaller quantity, those of the yttrium group. (U. S. Geol. Surv.)
2. A comparatively rare mineral closely related to common epidote and occurring generally as a microscopic constituent of igneous rocks. It contains a number of the rarer elements. (Ransome)

Allegheny formation. The second in order of age of the formations comprised in the Pennsylvanian series of strata in the bituminous coal districts of the northern Appalachian field. It overlies the Pottsville formation, comprises all the beds from the base of the Brookville coal to the top of the Upper Freeport coal, and is succeeded by the Conemaugh formation. It was formerly called the Lower Productive Coal Measures. (La Forge)

Allemontite. A rhombohedral or amorphous metallic tin-white or reddish-gray compound of antimony and arsenic, SbAs (Dana). Also called Arsenical antimony.

Allen-O'Hara furnace. A horizontal double-hearth furnace for calcining sulphide ores. (Peters, p. 201; Hofman, p. 198)

Alley stone. A synonym for Websterite (Chester). Aluminite.

Alliaceous. Applied to minerals having the odor of garlic, for example, arsenical minerals. (Dana)

Alligator. 1. *See* Squeezer. 2. A rock breaker operating by jaws. (Raymond).
3. (Aust.). A self-tipping tank, used for raising rock or coal. (Power)

Alligator wrench. A kind of pipe-wrench having a fixed flaring jaw with teeth on one side. (Webster)

Allingite. A fossil resin from Switzerland. *See also* Succinite. (Bacon)

All-mine pig. Iron smelted entirely from raw ore. (Standard)

Allochroite. A calcium-chromium garnet. (Dana)

Alloclasite; Alloclase. A steel-gray, cobalt-arsenic-bismuth sulphide, usually with part of the cobalt replaced by iron, Co(AsBi)S, that crystallizes in the orthorhombic system. (Dana)

Allomorph. In mineralogy, a pseudomorph formed without change of chemical composition, as calcite after aragonite. (Standard)

Allopalladium. A nearly silver-white palladium, found in hexagonal plates in the Harz Mountains, Germany. (Dana)

Allophane. A hydrous silicate of aluminum, amorphous, translucent, and of various colors, often in incrustations or stalactitic forms; $Al_2SiO_5 + 5H_2O$. (Webster)

Allothigene. In geology, produced from elsewhere; said of the ingredients of clastic rocks, or of the clastic ingredients of any rock: contrasted with Anthigene. (Standard)

Allotriomorphic. An adjective coined by Rosenbusch in 1887 to describe those minerals in an igneous rock that do not possess their own crystal faces or boundaries, but which have their outlines impressed on them by their neighbors. They result when a number of minerals crystallize at once so as to interfere with one another. They are especially characteristic of granitoid textures. The word was unnecessary, as xenomorphic had been suggested for the same thing, but it is in more general use than xenomorphic. *See also* Anhedron. Opposed to Idiomorphic. (Kemp)

Allotrope. One of the forms assumed by an allotropic substance; as the diamond is an allotrope of carbon. (Standard)

Allotropy; Allotropism. The capacity of existing in two or more conditions, that are distinguished by differences in properties. Thus carbon occurs crystalline as in the diamond, and amorphous as in charcoal. (Webster)

All over. End of a shift; when the breaker at a colliery shuts down for the day it is said to be "all over."

Allowance (Eng.). 1. Refreshment of bread, cheese, and beer supplied by the lessees or owners of a mine to surveyors. 2. Ale given to workmen on having to work under unusual conditions, for example, when they are wet through. (Gresley)

Allowance coal (Eng.). *See* Colliers' coal.

Alloy. 1. A compound of two or more metals, usually produced by fusion. When composed of two, three, or four metals or elements it is called respectively Binary alloy, Ternary alloy and Quarternary alloy.
2. The baser metal that reduces the commercial value of the compound or mixture as its proportion is increased; as, the alloy used for hardening gold and silver coins. (Standard)

Alloyage. The act or process of alloying: specifically, in minting, of alloying the precious metals with baser ones to harden them. (Standard)

Alloy balance. An adjustable balance that is in equilibrium when the metals in the scale pans are in the proper proportions for forming an alloy. (Standard)

Alloy cast-iron. Cast-iron alloyed with some other metal. (Webster)

Alloy steel. Steel that contains one or more elements other than carbon in sufficient proportion to modify or improve substantially and positively some of its useful properties. (Hibbard) *e. g.*, Manganese steel.

Alloy-treated steel. A simple steel to which one or more alloying elements have been added for curative purposes, but in which the excess of the element or elements is not enough to make it an alloy steel. (Hibbard)

All-sliming. Crushing all the ore in a mill to so fine a state of subdivision that only a small percentage will fail to pass through a 200-mesh screen.

All-ups (Lelc.). A mixture of every quality of coal, excepting fine slack, raised from one seam, and sold as such. (Gresley)

Alluvial. 1. Of or pertaining to alluvium. Relating to deposits made by flowing water. 2. Gold-bearing deposits of alluvium.

Alluvial epoch. The latter part of the Champlain period (Quaternary), overlying the Diluvial period, and characterized by the more quiet fluvial and lacustri · depositions. (Standard) Now obsolete.

Alluvial fan. The outspread sloping deposit of bowlders, gravel, and sand left by a stream where it spreads from a gorge upon a plain or open valley bottom. (Ransome)

Alluvial gold. Gold found in association with water-worn material. (Duryee)

Alluvial tin. Stream tin, or disintegrated cassiterite found in the gravel along the courses of valleys and rivers on the bedrock. Generally the purest tin ore.

Alluvião (Port.). Alluvium. (Halse)

Alluviation. The process of building alluvial deposits. (Standard)

Alluvion. 1. Wash or flow of water against a bank or shore. An overflowing; an inundation; a flood. 2. Synonymous with Alluvium, *which see.* (Webster)
3. A consolidated volcanic cinder-mud. (Standard) *See also* Tufa.

Alluvium. 1. Lyell's name for the deposit of loose gravel, sand and mud that usually intervenes in every district between the superficial covering of vegetal mould and the subjacent rock. The name is derived from the Latin word for an inundation. It was employed by Naumann as a general term for sediments in water as contrasted with eolian rocks. It is generally used today for the earthy deposit made by running streams, especially during times of flood. (Kemp)
2. *See* Alluvion, 3.

Allwork (Derb.). A term formerly used for longwall. (Gresley)

Almacén (Mex.). Warehouse. (Dwight)

Almacenista (Sp.). A store keeper; a person who sells goods in a warehouse. (Halse)

Almadén (Sp.). A mine or mineral deposit. (Halse)

Almadeneta. 1. (Mex.). Stamp head or shoe (Dwight)
2. (Sp.) A small hammer for breaking stones. (Halse)

Almagra (Sp.). A deep-red ocher originally from Andalusia, Spain, similar to Indian red: used as a pigment, and in polishing glass and metals. (Standard)

Almacral (Sp.). A place where red ocher is found. (Halse)

Almagre (Mex.). Red ocher. (Dwight)

Alman. *See* Almond furnace.

Almandite. An iron-aluminum garnet, $3FeOAl_2O_3.3SiO_2$. Used as a gem. (U. S. Geol. Surv.) Also called Almond stone.

Almártaga (Peru). Litharge. (Dwight)

Almendrilla (Sp. Am.). 1. Pudding stone; banket. (Lucas)
2. In Mexico, a quartz forming the matrix of a copper vein. (Halse)

Almocafre. 1. (Colom.) A kind of hoe used in placer mining. (Lock)
2. (Port.) A pick or mattock used in working mines. (Halse)

Almond furnace. A furnace in which the slags of litharge left in refining silver are reduced to lead by being heated with charcoal. (Century)

Almond rock. An amygdaloid. (Webster)

Almond stone. *See* Almandite.

Alnoite. A very rare rock with the composition of a melilite basalt. It was first discovered in dikes on the island of Alno, off the coast of eastern Sweden. The special name was given it by Rosenbusch to emphasize its occurrence in dikes and its association as a very basic rock, with nepheline syenite. Alnoite also occurs near Montreal, Canada, and at Manheim Bridge, N. Y. (Kemp)

Aloes rope. A special kind of rope, sometimes used in oil-well drilling, the breaking strain of which is 300 kg. per circular centimeter. It is manufactured from the aloe, a plant indigenous to Cape Colony. (Mitzakis)

Alpine glacier. A type of glacier occurring about the peaks and in the valleys and gorges of mountains, originating above by various branches in amphitheaters, terminating below, either by melting, or by spreading out into piedmont glaciers; an ice river. (Standard)

Alquifol (Sp.). Galena. (Min. Jour.)

Alquifou (Fr.). A coarse-grained galena used by potters in preparing a green glaze. Also called Potters' ore. (Standard)

Alquilar (Sp.). To hire; to let; to rent. (Halse)

Alquitrán (Sp.). Tar or liquid pitch; *A. de hulla*, coal tar; *A. mineral. See* Betún. (Halse)

Alsbachite. A variety of granite-porphyry containing large mica crystals and rose-red garnets. (Kemp)

Alshedite. A variety of titanite containing yttrium peroxide. Found in Sweden. (Standard)

Alstonite. *See* Bromlite.

Altai (Mongolia). Gold. (Lock)

Altaite. A lead telluride, PbTe, found in Colorado (U. S. Geol. Surv.). Originally found in the Altai mountains of Asia.

Altar of a reverberatory furnace. *See* Bridge, 1.

Alt-azimuth. An instrument for simultaneously observing the azimuth and altitude of a celestial body. (Webster)

Alteration. Strictly, any physical or chemical change in a rock or mineral subsequent to its formation. As ordinarily used, however, the term excludes cementation or induration of sediments to form hard rocks and implies change to such an extent that new minerals or new rock textures are developed. (La Forge)

Altered mineral. A mineral that has undergone more or less chemical change under the processes of nature. (Century)

Altered rock. A rock that has undergone changes in its chemical and mineralogical structure since its original deposition. (Weed)

Altern. A crystal form having opposite parts corresponding in form, but alternating with each other in the position of sides and angles. (Standard)

Alternating motion. Up and down, or backward and forward motion. (C. and M. M. P.)

Altitude. Vertical distance or elevation above any given point or base-level, as the sea; height; hence, also, such distance numerically expressed. (Standard)

Alto. 1. (Sp.) A bluff, height, hill. Used in southwestern United States. (Standard)
2. (Mex.) A hanging wall. *See also* Respaldo. (Dwight)

Altogether-coal (Eng.). Large and small coal mixed. (Gresley)

Alto horno (Sp.). Blast furnace. (Lucas)

Altura (Mex.). Height; altitude. (Dwight)

Aludel. One of a series of pear-shaped vessels of glass or earthenware fitted one into another and used for condensation, as in subliming mercury (Standard). *See also* Bustamente furnace.

Alum. 1. Specifically, the hydrous double sulphate of aluminum and potassium, found in nature as the mineral kalinite. 2. In chemistry, any one of a group of salts which are hydrous double sulphates of aluminum, chromium, iron, or manganese and one of the alkali metals. 3. In mineralogy, one of a group of minerals which are hydrous sulphates of aluminum and potassium, sodium, or ammonium. (La Forge)

Alumbrado (Sp.). Lighting. (Lucas)

Alumbre (Sp.). Alum; *A. de roca*, rock alum; *A. de piedra*, alumstone; alunite. (Halse)

Alum cake. A product of the action of sulphuric acid on clay, consisting chiefly of silica and aluminum sulphate. (Webster)

Alum earth. An argillaceous rock, containing considerable pyrite, and largely impregnated with bitumen. (Standard)

Alum feather. *See* Iron alum.

Alum flower. Powdered burnt alum. (Webster)

Alum glass. Crystallized alum.

Alumina. Oxide of aluminum, Al_2O_3. Pure crystalline alumina is represented by corundum, sapphire, and ruby. The commonest form of alumina is as a silicate, of which clays are mostly composed, and as the compound silicates of aluminum and other metals, of which a large class of minerals is formed. (Roy. Com.)

Aluminite. A hydrous sulphate of aluminum, $Al_2O_3.SO_3.9H_2O$, usually occurring in white reniform masses. (Dana)

Aluminium. *See* Aluminum.

Aluminous. Of the nature of alumina or clay. (Hitchcock)

Aluminum. A bluish silver-white metal, malleable, ductile, sonorous, noted for its lightness and resistance to oxidation. Symbol, Al; atomic weight, 27.1; specific gravity 2.7 (Webster). Also Aluminum.

Aluminum bronze, or Aluminum gold. An alloy of aluminum and copper resembling pale gold: used in cheap jewelry, etc. (Standard). As a powder, used in gilding.

Aluminum minerals. Alunite, amblygonite, andalusite, bauxite, corundum, cryolite, cyanite, diaspore, sillimanite, spinel, topaz, turquois, wavellite, and many silicates. (A. F. Rogers)

The commercial ores of aluminum are cryolite, a fluoride of sodium and aluminum, found in Greenland; bauxite, a hydrous compound of alumina, ferric oxide, and silica, found in Arkansas, Georgia, and Tennessee.

Aluminum silver. A bright alloy of aluminum and silver, used in instruments where lightness is an object, the lightness increasing with the proportion of aluminum. (Standard)

Aluminum solder. An alloy of gold, silver, and copper, with sometimes a little zinc. Used for soldering aluminum bars. (Standard)

Alumocalcite. A variety of opal with alumina and lime as impurities. (Dana)

Alum salts. Natural salts from which alum can be made. *See also* Halloysite, Kaolinite. (U. S. Geol. Surv.)

Alum schist, shale, or slate. A clayey rock containing carbonaceous material and marcasite that when decomposed yields by efflorescence common alum. (Standard) *See also* Alum shale.

Alum shale. Shale charged with alum, that in favorable localities may be commercially leached out and crystallized. The alum results from the decomposition of pyrite, because the sulphuric acid, thus produced, reacts on the alumina present, yielding a double sulphate. (Kemp)

Alum slate. *See* Alum schist, and Alum shale.

Alum stone. An impure siliceous alunite. (A. F. Rogers)

Alundum. An artificial abrasive used in the manufacture of oilstones and grinding wheels. Made by fusing the natural mineral bauxite in electric furnaces. Alundum has the same chemical composition as the natural mineral corundum. (Pike)

Alunite; Alumstone. A hydrous sulphate of aluminum and potassium, $K(AlO)_3(SO_4)_2.3H_2O$, containing 11.4 per cent potash, K_2O. (U. S. Geol. Surv.) Closely resembles kaolinite and occurs in similar locations. Generally the result of the action of water, containing sulphuric acid, on feldspathic rocks, as when pyrite in granite porphyry is oxidized. (Ransome)

Alunogen. A hydrous aluminum sulphate, $Al_2(SO_4)_3+18H_2O$, frequently found on the walls of mines and quarries. Also called Feather alum and Hair salt. (Webster)

Alurgite. A purple to red variety of manganese mica from St. Marcel, Piedmont. (Dana)

Alutación (Sp.). A nugget, or a layer of gold in grains found at or near the surface of the ground. (Halse)

Aluviónes (Sp.). Alluvial deposits. (Lucas)

Alvará (Port.). A definite title or patent for a concession. (Halse)

Alvecas (Peru). A name given to the three tubes leading from the furnace to the aludeles. (Halse)

Álveo (Port.). The bed of a river. (Halse)

Alza (Bol.). Separating gold from sand in a washer. (Halse)

Alzador (Mex.). Workman employed in loading wagons, etc. (Dwight)

Alzas (Peru). The upper portion of a mine. (Halse)

Amagamiento (Sp. Am.). Rivulet; ravine; torrent. (Lucas)

Amain (Eng.). With great force or speed. Wagons or tubs are said to run amain, if by accident they go over an incline, bank, or dump, without the rope being attached; or through the rope becoming detached or broken. (G. C. Greenwell)

Amalgam. 1. A native compound of silver and mercury, in which the percentage of silver ranges from 27.5 to 95.8. Native gold amalgam carrying 39 to 42.6 per cent gold has also been found. (U. S. Geol. Surv.)

2. An alloy or union of mercury with another metal. Amalgams are made by bringing mercury in contact with another metal, a salt of another metal, or by placing the metal in a salt of mercury. 3. In gold metallurgy, an alloy of gold

and mercury, usually obtained by allowing gold-bearing minerals, after crushing, to come in contact with mercury in stamp batteries, sluices, or mercury-coated copper plates. The alloy (amalgam) is collected and the mercury is driven off by distillation, the gold remaining in the retort.

Amalgama (Sp.). Amalgam. (Dwight)

Amalgamar (Sp.). To amalgamate. (Lucas)

Amalgam arc. An arc in a vacuum tube having electrodes of mercury amalgamated with zinc, cadmium, or other metal. The spectra of such arcs contain the bright lines of the metals in the electrodes. (Webster)

Amalgamate. 1. To unite (a metal) in an alloy with mercury. 2. To form an amalgam with; as, mercury easily amalgamates with gold. (Standard)
3. To merge two or more corporations into a single body. (Webster)

Amalgamated claims (Eng.). Mining claims adjoining one another that have been grouped into one claim for more economical working. (Duryee)

Amalgamating-barrel. A short cylindrical vessel or barrel with solid ends turned to fit bearings. The barrel is used for amalgamating battery accumulations and other material. It is run with intermittent charges, and contains a load of steel balls or pebbles to effect comminution and to bring the mercury into contact with the metal to be amalgamated. Charging and discharging are done through suitable doors.

Amalgamation. 1. The production of an amalgam or alloy of mercury. 2. The process in which gold and silver are extracted from pulverized ores by producing an amalgam, from which the mercury is afterward expelled. *See also* Retorting. (Raymond)

Amalgamation-pan. A pan in which the process of amalgamation or combination with mercury is effected (Rickard). Used in gold and silver metallurgy.

Amalgamator. An apparatus used in metallurgy for bringing pulverized ore into close contact with mercury to extract free metal from it by amalgamation. *See* Amalgamation pan; *also* Amalgamating-barrel. (Standard)

Amalgam gilding. A process of gilding in which a metallic surface is coated with gold amalgam and the mercury driven off by heat. (Standard)

Amalgam retort. An iron retort having a convex lid, luted at the edges, and held by a key or wedge pressed between its crown and the bail. The retort is arranged so that heat enough to volatilize the mercury can be applied; and a suitable exit pipe is connected to a condenser, or merely cooled with circulating water at a safe distance from the retort.

Amalgam silvering. A process of silvering similar to amalgam gilding. (Standard)

Amarantite. A monoclinic hydrous-ferric sulphate, $Fe_2O_3.2SO_3.7H_2O$. (Dana)

Amarillo (Sp.). Yellow. *A. de montaño*, yellow earth; orcherous clay. (Halse)

Amarrar las aguas (Sp. Am.). To clear the mine or pit of water, by means of trenches. (Lucas)

Amas (Sumatra). Gold; *A. Lichin*, nugget-gold; *A. Muda*, inferior gold; *A. Supayang*, vein-gold; *A. Urei*, gold dust. (Lock)

Amatista (Sp.). Amethyst. (Vel.)

Amatito. A red pigment prepared from hematite; formerly used in frescoing. (Standard)

Amatrice. *See* Variscite.

Amausite. Same as Petrosilex. (Standard)

Amazonite. *See* Amazon stone.

Amazon stone; Amazonite. A green microcline. A variety of orthoclase. Used as a gem. (Dana)

Ambar. The Russian name given to excavations dug around a derrick forming small reservoirs, where the sand raised from the bore-hole is deposited. Also used as a temporary reservoir for oil. (Mitzakis)

Ámbar (Sp.). Amber; *Á. negro*, jet. (Halse)

Amber. A hard, brittle, translucent, fossilized vegetal resin, of a clear yellowish-brown or light-yellow color. Called in mineralogy Succinite. (Standard)

Amber forest. A fossil forest from which amber has been formed. (Webster)

Amblygonite; Hebronite. A fluo-phosphate of aluminum and lithium $Li(AlF)PO_4$. Used in the manufacture of lithium preparations in medicine. (Dana)

Amblystegite. A dark brownish-green to black magnesium-iron metasilicate, $(Mg.Fe)SiO_3$, that crystallizes in the orthorhombic system, and is closely related to hypersthene. (Standard)

Ambrite. A greasy, yellowish-gray fossil resin, resembling Kauri-gum, found in New Zealand; sometimes used as jewelry. (Standard)

Ambroid. A reconstructed amber, made by heating and uniting by pressure fragments of amber. (Standard)

Ambrosine. A yellowish to clove-brown resin found in the phosphate beds near Charleston, S. C.; it may be a modern resin that has been subjected to the action of salt water. (Bacon)

Amercement (Derb.). A fine in the barmote court, imposed on a miner for violation of the laws. (Mander)

American-Belgian furnace. A direct-fired Belgian furnace employed in the United States, conforming essentially to the Liège design, but presenting minor differences because of local adaptation. (Ingalls, p. 433)

American forge. *See* Catalan forge; Champlain forge.

American paraffin-oil. An English term for kerosene of American origin. (Bacon)

American pump. A special kind of bailer, used in oil fields for cleaning out wells (Mitzakis). *See also* Bailer.

American system of drilling. *See* Cable system.

American vermilion. A basic chromate of lead. (Webster)

Amethyst. A purple or bluish-violet quartz, SiO_2. Used as a gem. (U. S. Geol. Surv.)

Amethystine quartz. A phenocrystalline variety of quartz colored purplish or bluish-violet by manganese (Standard). *See also* Amethyst.

Amianthinite. Asbestos. (Standard)

Amiantho (Port.). Same as Amianto.

Amianthus. One of the finer and more silky varieties of asbestos. Called also Earth-flax and Mountain-flax. (Standard)

Amianto (Sp.). Amianthus; a fine silky variety of asbestos. (Halse)

Amiantoid. 1. Having the appearance of asbestos. 2. An olive-green, coarse, fibrous variety of asbestos. Called also Byssolite. (Standard)

Ammite. Oölite; roestone. (Standard)

Ammonal. An explosive consisting of a mixture of powdered aluminum (1 part), and nitrate of ammonium (8 parts).

Ammonia. A colorless gaseous compound of hydrogen and nitrogen (NH_3) with extremely pungent smell and taste. Sp. Gr. as compared with air, 0.589. (Webster)

Amonia gelatin. An explosive consisting of blasting gelatin, ammonium nitrate, and charcoal. (Webster)

Ammonia oil. An oil suitable for the lubrication of the cylinders of ammonia compressors. Low cold-test is essential for this purpose. (Bacon)

Ammonite. Ammonium nitrate explosives, containing from 70 to 95 per cent ammonium nitrate, besides combustile components, which are so-called carbon carriers, as resin, meal, naphthalene. (Brunswig, p. 305)

Amo. 1. (Sp.) An overseer. 2. (Mex.) An owner of a mine. (Halse)

Amojonar (Mex.). To set monuments or landmarks. (Dwight)

Amolinar (Sp. Am.). To wash the auriferous alluvion in a wooden trough. (Lucas)

Amonedar (Sp.). To coin. (Min. Jour.)

Amoniaco (Mex.). Ammonia. (Dwight)

Amontonar (Sp.). To pile up; to make into heaps. (Halse)

Amorfo (Mex.). Amorphous. (Dwight)

Amorphism. The state or quality of being amorphous; especially, the absence of crystalline structure. (Standard)

Amorphous. Without form; applied to rocks and minerals having no definite crystalline structure. (Roy. Com.)

Amorphous phosphorus. A reddish-brown, nontoxic, allotropic modification of phosphorus obtained by heating common phosphorus to about

450° F. in air-tight vessels; largely used for safety matches. Called also Red phosphorus. (Standard)

Amortization. The repayment of a debt, principal and interest, in equal annual installments. Frequently used in finance as the extinction of a debt, regardless of the means employed. (E. B. Skinner, p. 114). Important in connection with mining finance.

Amortization schedule. In finance, a table so constructed as to show the principal remaining due or outstanding immediately after the annual payment, the interest for the interval, and the amount of principal repaid. (E. B. Skinner, p. 121)

Amortize. To clear off, liquidate, or otherwise extinguish, as a debt. To extinguish by periodically charging off a portion so as to bring the value to par at maturity. (Webster)

Amparar (Mex.). 1. To cover (title). (Dwight)
2. *A. en la posesión*, to maintain in possession. (Halse)

Amparo (Sp.). Continued possession of a mine to secure title; keeping the necessary number of men at work in accordance with mining laws. (Crofutt)

Ampelite. 1. A name, specially current among the French, for shales, charged with pyrite and carbonaceous matter, that may yield alum-shales. (Kemp)
2. Cannel coal; also carbonaceous schist. (Webster)

Amperage. The strength of an electric current measured in amperes. (Century)

Ampere. The practical unit of electric current; the current produced by 1 volt acting through a resistance of 1 ohm. (Webster)

Ampere foot. One ampere flowing through 1 foot of an electric conductor. A wire 20 feet long conducting a current of 6 amperes is said to have 120 ampere feet. (Standard)

Ampere hour. The quantity of electricity delivered in 1 hour by a current whose average strength is 1 ampere. (Webster)

Ampere meter. An instrument for measuring in amperes the strength of an electric current; an ammeter. (Standard)

Ampere turn. A unit equal to the product of one complete convolution of a coiled conductor into 1 ampere current. Thus a conductor having 5 convolutions with ½ ampere current is said to have 2½ ampere turns. (Webster)

Ampere volt. A watt. (Standard)

Amphibole. The generic name for the group of bisilicate minerals whose chief rock-making member is hornblende. It is often prefixed to those rocks that have hornblende as a prominent constituent, as amphibole-andesite, amphibole-gabbro, amphibole-granite, etc. (Kemp). *See also* Hornblende.

Amphibolite. A metamorphic rock consisting chiefly of hornblende, or of some member of the amphibole group. It is, as a rule, a synonym of hornblende schists, but is preferable to the latter, when the schistosity is not marked. (Kemp)

Amphibolization. Metamorphic alteration of other material into amphibole. (Standard)

Amphigène. Leucite, $K_2O.Al_2O_3.4SiO_2$. (Dana)

Amphigenite. Lava containing amphigène. (Standard)

Amphimorphic. In geology, formed by a two-fold process, as the action of mineral-bearing thermal springs upon sedimentary argillaceous deposits during deposition. (Standard)

Ampliación (Mex.). The enlargement of a mining claim. (Dwight)

Ampollosa (Mex.). Rock structure containing cavities. (Dwight)

Amurang (Ceylon). Gold ore. (Lock)

Amygdaloidal. Relating to an amygdule.

Amygdaloid. A vesicular or cellular igneous rock, ordinarily basaltic, in which the vesicles have been partly or wholly filled with a secondary deposit of calcite, quartz, epidote, native copper, or zeolites. (La Forge). The term is used in the form of the adjective, amygdaloidal, and properly should be limited to this. As a noun it is also employed for secondary fillings of the cavities, which are usually calcite, quartz, or some member of the zeolite group. Amygdaloidal rocks are of chief interest in America because certain basaltic lava sheets on Keweenaw Point,

Lake Superior, have their amygdules filled with native copper and are important sources of the metal. Amygdaloidal cavities are limited to the upper and lower portions of lava sheets. The name is derived from the Greek word for almond. (Kemp)

Amygdule. A small globular cavity in an eruptive rock caused by steam or vapor at the time of its eruption and generally lined afterwards with secondary minerals. (U. S. Geol. Surv. Bul. 521, p. 162)

Anabranch (Aust.). An effluent of a stream that rejoins the main stream, forcing an island between the two watercourses. (Standard)

Anaclinal. Descending in a direction opposite to the dip of the strata, as an anaclinal river. Opposed to Cataclinal. (Webster)

Añagua (Arg.). A shrub used as fuel in high desert regions. (Halse)

Analcite. A hydrous sodium-aluminum silicate, $NaAlSi_2O_6+H_2O$, belonging to the zeolite group. (Dana)

Analcite-basalt. A variety of basalt whose feldspar is more or less replaced by analcite. The analcite is in places in such relations as to give reason for thinking it an original mineral and not an alteration product from feldspar. Analcite-basalts occur in the Highwood mountains, Mont. Analcite-diabase has been found in California. *See also* Teschenite. (Kemp)

Analcite-tinguaite. Tinguaite (*which see*) with considerable analcite. (Kemp)

Analcitite. Pirsson's name for the olivine-free analcite-basalts. (Kemp)

Analizar (Mex.). To analyze. (Dwight)

Analysis. Specificially, in chemistry and mineralogy, the determination, by chemical methods, of the nature and proportionate amounts, and sometimes also of the manner of combination, of the elementary constituents of a compound substance, as a mineral or a rock. Also, loosely, a tabular statement of the result of such an analysis. (La Forge)

Analyzer. That part of a polariscope that receives the light after polarization, and exhibits its properties. (Webster)

Anamesite. An old name suggested by von Leonhard in 1832 for those finely crystalline basalts that texturally stand between the dense typical basalt and the coarser dolerites. The name is from the Greek for "in the middle." (Kemp)

Anamorphic zone. A zone corresponding to the zone of rock-flowage. It is especially characterized by silicatization involving decarbonation, dehydration and deoxidation; the processes are constructive. *See also* Katamorphic zone. (Watson)

Anamorphism; Anamorphosis. Metamorphism at considerable depths in the earth's crust and under great pressure, resulting in the formation of complex minerals from simpler ones. (La Forge)

Anatase (Fr.). Same as Octahedrite. (Standard)

Anatexis. A refusion of igneous rocks. (Daly, p. 309)

Anchi eutectic. Magmas which are incapable of undergoing notable differentiation. (Daly, p. 360)

Ancho (Sp.). Wide. *See* Anchura. (Halse)

Anchor. An iron plate used in withdrawing coke from a coke oven. (Standard)

Anchor bolt. A foundation bolt; a drift spike, or other device used for holding any mechanism or structure down. It may or may not be threaded.

Anchor ice. *See* Ground ice.

Anchor oven. An oven from which coke is removed with an anchor-shaped rabble. (Standard)

Anchura (Sp.). 1. Width or thickness of a mineral deposit. 2. The widening of a vein. 3. The width of a gallery, etc. (Halse)

Anchurón (Sp.). A large room opened in massive ore deposits. (Halse)

Ancla (Mex.). Anchor; hook. (Dwight)

Ancón de tierra (Mex.). A projecting or salient corner of a mining claim. (Dwight)

Andalusite. An aluminum silicate Al_2SiO_5. Sometimes used as a semi-precious stone. (Dana)

Andalusite-hornstone. A compact contact rock containing andalusite. It is usually produced from shale or slate by intrusions of granite. (Kemp)

Andamio (Mex.). 1. Builders' jack. 2. A scaffold. (Dwight)

Andarivel (Sp.). An overhead cableway. (Lucas)

Andén (Sp.). 1. A path for horses around the shaft, as at a horse whim. (Dwight)
2. A railroad station platform. (Halse)

Andendiorite. A Tertiary quartz-augite-diorite that occurs in areas like islands in the midst of the volcanic rocks of the Chilean Andes. The quartz crystals are remarkable for their inclusions of glass and of fluids with salt crystals. (Kemp)

Andengranite. A biotite-bearing hornblende-granite, similar in occurrence and microscopic features to Andendiorite. (Kemp)

Andesine. One of the plagioclase feldspars. Intermediate between albite and anorthite (Dana). A silicate of sodium, calcium, and aluminum, with the sodium in excess of the calcium. An important constituent of andesite and diorite. (Ransome)

Andesita (Mex.). Andesite. (Dwight)

Andesite. A volcanic rock of porphyritic or felsitic texture, whose crystallized minerals are plagioclase and one or more of the following: biotite, hornblende, and augite. The name was suggested by L. von Buch in 1836, for a certain rock from the Andes resembling trachyte, but whose feldspar was at first thought to be albite, and later oligoclase. (Kemp)

Andradite. The common calcium-iron garnet, $Ca_3Fe_2(SiO_4)_3$. (Dana)

Anegada (Mex.). Drowned; overflowed; left to fill with water. (Dwight)

Anemometer. An instrument for measuring the velocity of air currents; specifically, in mines, a common form consists of a small delicately mounted disk fan connected by means of gears with indicating dials. Especially useful when air current is over 100 feet per minute.

Anemometry. The process of determining the pressure or velocity of the wind (air) by means of an anemometer. (Century)

Aneroid barometer. An instrument for showing the pressure of the atmosphere by means of the movements of the elastic top of a metallic box from which the air has been partly exhausted. The most sensitive aneroids show the variation of pressure due to a difference of height of a few feet; hence the instrument is much used in measuring altitudes (Standard). *See also* Barometer.

Anfibolita (Sp.) Amphibolite. (Lucas)

Angle. 1. The figure formed by two meeting lines (plane angle), two meeting planes (dihedral angle), or three or more planes meeting in a point (solid angle). 2. The difference in direction of two lines. 3. A projecting or sharp corner. (Webster)

Angle beam. A two-limbed beam used for turning angles in shafts, etc. (C. and M. M. P.)

Angle brace. A brace used to prevent mine timbers from riding or leaning (Sanders, p. 156). A brace across an interior angle.

Angle of dip. A synonym for Dip.

Angle of incidence. The angle formed by the line of incidence and a line drawn from the point of contact perpendicular to the plane or surface on which the incident ray or body impinges. (Century)

Angle iron. A bent piece of iron used for joining two or more parts of a composite structure at an angle. Also a rolled shape largely used in structural work.

Angle of nip. The angle between tangents drawn to an ore particle at the point of its contact with the surface of the rolls. (Richards)

Angle of polarization. That angle whose tangent is the index of refraction of a reflecting substance. (Dana)

Angle of pull. The angle between the vertical and an inclined plane bounding the area affected by the subsidence beyond the vertical. Applied to slides of earth. (Watson)

Angle of rest or repose. The angle with a horizontal plane at which loose material will stand on a horizontal base without sliding. It is often between 30° and 35°. (Webster)

Angle of slide. The slope, measured in degrees of deviation from the horizontal on which a slide of material will start (Watson). It is slightly greater than the angle of rest.

Anglesite. Lead sulphate, $PbSO_4$, containing 68 per cent lead. (Dana)

Angleur furnace. A furnace for the distillation of zinc. (Ingalls, p. 448)

Angostura (Sp.). Narrowness; a narrow mountain pass. (Halse)

Ángulo (Mex.). Angle. (Dwight)

Angus Smith composition. A protective coating for valves, fittings, and pipe used for underground work. It is composed of coal tar, tallow, resin, and quicklime, and must be applied hot. (Nat. Tube Co.)

Anhedral. Having a form determined by the surrounding crystals; allotriomorphic; xenomorphic; said of minerals in a granular igneous rock. Contrasted with Euhedral and Subhedral. (La Forge)

Anhedron. A name proposed by L. V. Pirsson for the individual mineral components of an igneous rock that lack crystal boundaries, and that can not therefore be properly called crystals according to the older and most generally accepted conception of a crystal. Xenomorphic and allotriomorphic are adjectives implying the same conception. The name means without planes. (Kemp)

Anhydride. An oxide of a nonmetallic body, or an organic radical, capable of forming an acid by uniting with water, or of being formed from an acid by the abstraction of the water, or of uniting with basic oxides to form salts. (Webster)

Anhydrite. Calcium sulphate, $CaSO_4$, or $CaO.SO_3$. Contains 41.2 per cent lime and 58.8 per cent sulphur trioxide. Usually associated with gypsum, to which it alters. Differs from it in being harder and in lacking water of crystallization. (U. S. Geol. Surv.)

Anhydrous. Destitute of water, especially water of crystallization. (Webster)

Añilado (Sp.). An indigo-colored copper ore. (Halse)

Anillo (Mex.). Ring; collar; loop on the end of a rope. In the plural, a set of shaft-timbers; shells for crushing-rolls. (Dwight)

Animikean system. The middle subdivision of the Proterozoic era, sometimes known as the Upper Huronian or Penokean. (Chamberlin, vol. 2, p. 183)

Animikite. A white to gray silver antimonide, Ag_3Sb, that is found in fine granular masses in the Lake Superior region. (Standard)

Anisometric. Having unsymmetrical parts. Not isometric. (Webster)

Anisotropic. Not having the same properties in all directions with regard to light; characteristic of all crystalline minerals except those of the isometric system. (Power)

Ankerite. A white, red, or grayish calcium-magnesium-iron carbonate, $CaCO_3(Mg,Fe,Mn)CO_3$ (Dana)

Ankylostomiasis. A disease due to the presence of parasites in the small intestines. When present in large numbers, by sucking the blood from the intestinal walls they produce a severe anemia (Webster). Also called Miner's worm; Hookworm; Tunnel disease.

Anna. An East Indian money of account, one-sixteenth rupee, or about two cents. (Webster)

Annabergite. A hydrous nickel arsenate, $Ni_3As_2O_8.8H_2O$. (U. S. Geol. Surv.)

Anneal. 1. To heat, fire, bake, or fuse, as glass, earthenware, ore, etc. 2. To heat, as glass, earthenware, or metals in order to fix colors. 3. To treat, as glass, earthenware, or metals, by heating and gradually cooling, so as to toughen them and remove brittleness. (Century)

Annealed steel. Steel that has been subjected to an annealing operation. (Hibbard)

Annealed wire rope. A wire rope made from wires that have been softened by annealing. (C. M. P.)

Annealing. 1. The process by which glass and certain metals are heated and then slowly cooled to make them more tenacious and less brittle. Important in connection with the manufacture of steel castings, forgings, etc. 2. *See* Malleable castings.

Annealing-arch. The oven in which glass is annealed. (Century)

Annealing-box. A box in which articles to be annealed are enclosed while in the furnace (Standard). Also called Annealing pot.

Annealing-color. The hue taken by steel in annealing. (Standard)

Annealing-furnace. *See* Annealing oven.

Annealing-oven. An oven or furnace for heating and gradually cooling metals or glass to render them less brittle (Standard). Also called Annealing furnace.

Annealing-pot. A closed pot in which articles are placed to be annealed or subjected to the heat of a furnace. They are thus enclosed to prevent the formation of oxide upon their surfaces (Century). Also called Annealing-box.

Annerödite. A submetallic black uranium-yttrium pyroniobate, crystallizing in the orthorhombic system. (Dana)

Annual labor. Same as Assessment work on mining claims. (U. S. Min. Stat., p. 232–253)

Annuity. 1. An annual allowance, payment, or income. 2. The return from an investment of capital with interest in a series of yearly payments. (Standard)

Annular borer. A tool with a tubular bit for removing a cylindrical core as a sample. Used in prospecting (Standard). *Compare* Diamond drill; Adamantine drill; Shot drill.

Annular kiln. A kiln having compartments. (Standard)

Anode. The positive terminal of an electric source, or more strictly the electrode by which the current enters an electrolyte on its way to the other pole. Opposed to Cathode. (Webster)

Anode copper. Crude-copper plates, usually cast from the converter, used as anodes in the electrolytic process of refining copper.

Anodo (Sp.). Anode. (Halse)

Anogene. An old name for rocks that have come up from below; *i. e.*, eruptive rocks. (Kemp)

Anomalies. As applied to crystals, refers to lack of harmony of optical phenomena with apparent symmetry of external form. (Dana)

Anomite. A variety of biotite. (Standard)

Anorthic. In crystallography, same as triclinic. (Standard)

Anorthite. An end-member of the plagioclase feldspar series, the one consisting of calcium-aluminum silicate and containing no sodium. The intermediate plagioclases may be regarded as mixtures of anorthite with the other end-member, albite (Ransome). *Compare* Albite.

Anorthite rock. A coarsely crystalline granitoid igneous rock that consists almost entirely of anorthite. It was observed on the Minnesota shore of Lake Superior. The rock is a feldspathic extreme of the gabbro group, practically an anorthosite formed of anorthite. (Kemp)

Anorthoclase. A triclinic feldspar closely related to the orthoclase group. Chiefy a soda-potash feldspar. (Dana)

Anorthosite. A name applied by T. Sterry Hunt to granitoid rocks that consist of little else than labradorite and that are of great extent in eastern Canada and the Adirondacks. The name is derived from *anorthose*, the French word for plagioclase, and is not to be confused with anorthite, with which it has no necessary connection, although anorthosite is used as a general name for rocks composed of plagioclase. The rocks are extremes of the gabbro group into whose typical members they shade by insensible gradations. (Kemp)

Anqueria (Peru). Silver ore which has the appearance of cubical galena. (Dwight)

Anquerita (Mex.). Ankerite. (Dwight)

Anta (Peru). Copper; *A. charca*, a copper mine. (Halse)

Antecedent. 1. Pertaining to or characterizing the internal movements of the earth concerned in the elevation of continental masses and their exposure to degradation. Contrasted with *consequent*. 2. Established previous to the displacement of a terrane by faulting or folding; as an *antecedent* valley, *antecedent* drainage. Contrasted with *consequent* and *superimposed*. Epigenetic. (Standard)

Antecedent streams. Streams that hold their early courses in spite of changes since their courses were assumed. (Chamberlin vol. 1, p. 161)

Anthraciferous. Yielding anthracite. (Webster)

Anthracite; Hard coal. A hard black lustrous coal containing 85 to 95 per cent carbon as against 70 to 85 per cent in bituminous or "soft" coal. *See also* Coal. (U. S. Geol. Surv.) Characterized by its small percentage of volatile matter, high specific gravity, hardness, nearly metallic luster, rich black color, and semi-conchoidal fracture. It ignites with difficulty, produces an intensely hot fire, giving off no smoke, and burns with a very small blue flame of carbonic oxide (produced by incomplete combustion), which disappears after the coal is thoroughly ignited. Volatile matter is usually less than 7 per cent. (Chance)

Anthracolite. Same as Anthraconite. (Standard)

Anthraconite. A coal-black bituminous marble or limestone usually emitting a fetid smell when rubbed. Also called Stinkstone and Swinestone. (Webster)

Anthracosis. Chronic inflammation of the lungs, produced by inhaling particles of solid matter, as coal dust; the 'blacklung' of coal workers. (Standard)

Anthracoxenite. A black powder obtained from a resinoid material in the coal beds of Brandeisl, near Schlan in Bohemia. The resin is treated with ether which dissolves the schlanite, leaving the insoluble portion, anthracoxenite. (Bacon)

Anthrax. A gem stone of the ancients; probably identical with the carbuncle. (Standard)

Anthraxolite. A black combustible coal-like substance of varying composition, occurring in Ontario and Quebec. (Bacon)

Anticaustic. 1. Checking or preventing the corrosive action of caustics. 2. Any remedy for arresting or mitigating the action of caustics. (Standard)

Anticlinal. Of, or pertaining to, an anticline. (Webster). The crest of an anticlinal roll may be the apex of a vein. (Tonopah Min. Co. *v.* West End Cons. Min. Co. 158 Pacific, p. 881)

Anticlinal flexure; Anticlinal fold. *See* Anticlinal; Anticline.

Anticlinal line or axis. In geology, the medial line of a folded structure from which the strata dip on either side. (Century)

Anticline. A fold or arch of rock strata, dipping in opposite direction from an axis. (Webster)

Anticlinorium. A series of anticlines and synclines, so grouped that taken together they have the general outline of an arch; opposed to Synclinorium. (Webster)

Antifriction metal. Any alloy having a low coefficient of friction: used for bearing surfaces. (Standard)

Antigos (Braz.). "Old men," or old workings (Halse). *Compare* Antiguo.

Antiguo, gua (Mex.). A mine worked by Spaniards or Mexicans at a time so remote (from 50 to 300 years) that particulars have been forgotten. (Weed)

Antimonial silver. Same as Dyscrasite. (Standard)

Antimonide. A binary chemical compound of which antimony is one constituent. (Webster)

Antimonio (Mex.). Antimony; *A. blanco*, valentinite; *A. rojo*, kermesite. (Dwight)

Antimonite. The native sulphide of antimony; stibnite. (Century)

Antimony. An element of metallic appearance and crystalline structure, tin-white in color, hard, and brittle. Occurs in free tate and combined in various minerals. Symbol, Sb; Atomic weight, 120.2. Specific gravity, 6.7. (Webster)

Antimony blende. Same as Kermesite.

Antimony bloom. A synonym for Valentinite, which is often found as an efflorescence (Chester). Sb_2O_3.

Antimony glance. Synonym for Stibnite. (A. F. Rogers)

Antimony ocher. A synonym for Stibiconite, *also* Cervantite.

Antimony ores. Native antimony; stibnite (sulphide of antimony); valentinite, and senarmontite (oxides). (Raymond)

Antimony regulus. An impure product of the smelting process: largely antimony sulphide. (Standard)

Antimony star. The fern-like markings on the upper surface of the metal antimony when well crystallized.

Antimony vermilion. 1. A fine vermilion pigment prepared by treating antimony chloride or tartar emetic with a thiosulphate, in solution. (Webster)
2. A sulphide of antimony suggested for, but never used as, a pigment. (Century)

Antimony white. Antimony trioxide, Sb_2O_3. (Webster)

Antisepsis. Prevention of sepsis by excluding or destroying micro-organisms. (Webster)

Antiseptic. That which may be used to destroy bacteria with little or no harmful effect on the living body. Very common antiseptics are aqueous solutions of carbolic acid and of corrosive sublimate.

Antitoxic. Counteracting poison. (Webster)

Antlerite. A light-green basic sulphate of copper, $3CuSO_4.7Cu(OH)_2$, found in Arizona. (Dana)

Antozonite. A dark violet-blue fluorite that emits an odor often causing nausea among miners. Formerly ascribed to hydrogen dioxide, but now known to be free fluorine.

Antracita (Mex.). Anthracite. (Dwight)

Anvil. 1. A block, usually of iron, steel-faced, and of characteristic shape on which metal is shaped, as by hammering and forging. (Webster)
2. An iron block placed between a stamp-mill mortar box and the foundation block; generally used in light mortars and concrete foundations.

Anvil vise. A vise of which an anvil forms one jaw. (Webster)

Apachite. A name suggested by Osann, from the Apache, or Davis mountains of western Texas, for a variety of phonolite, that varies from typical phonolites in two particulars: It has almost as much of amphibole and of ænigmatite as of pyroxene, whereas in normal phonolite the former is rare. The feldspar of the groundmass is generally microperthitic. (Kemp)

Apagar (Sp.). To quench; to extinguish; *A. un horno*, to blow out a furnace. (Halse)

Apalancar. 1. (Mex.) To move with a lever. (Dwight)
2. (Sp.) To get ore. (Halse)

Aparador (Mex.). Re-worker of tailings from silver mills. (Dwight)

Aparato (Mex.). Apparatus. (Dwight)

Aparejo (Mex.) 1. Packsaddle. 2. Any rough apparatus for moving heavy timbers, etc. (Dwight) A block and tackle.

Aparinar (Sp. Am.). To disclose indications of pay ore. (Lucas)

Apartado (Mex.). 1. Ore separation or concentration. Parting gold and silver. 2. The place where this work is performed. (Dwight)
3. Postoffice box. (Halse)

Apartador (Mex.). Hand-sorter of ore. (Dwight)

Apartar (Sp.). 1. To pick by hand, sort, cob, or break ore. 2. In assaying, to part. (Halse)

Apatelite. A hydrous ferric sulphate, found in yellow nodules in clay. (Chester)

Apatite. A calcium phosphate containing a little fluorine or chlorine, $Ca_4(CaF)(PO_4)_3$ or $Ca_4(CaCl)(PO_4)_3$. The fluor-apatite contains 42.3 per cent P_2O_5 and the chlor-apatite 41 per cent P_2O_5. (U. S. Geol. Surv.)

Apeador. A land surveyor. (Halse)

Apeadura (Sp.). Surveying. (Halse)

Apelmazado (Mex.). Compressed ground. (Dwight)

Apeo (Sp.). 1. Timbering; *A. por estacas*, piling, spiles. 2. Surveying. (Halse)

Aperador (Mex.). Storekeeper. (Dwight)

Aperos (Mex.). A general term for mining supplies. (Dwight)

Apex. 1. The tip, point, or angular summit of anything, as the apex of a mountain. The end, edge, or crest of a vein nearest the surface. (Webster)
2. The highest point of a stratum, as a coal seam. (Standard)
3. In geology, the top of an anticlinal fold of strata. This term, as used in United States Revised Statutes, has been the occasion of much litigation. It is supposed to mean something nearly equivalent to outcrop. (Century)
4. The highest point at which the ore or rock is found in place or between the walls of the vein, and not a "blow-out" or part of the vein

broken down outside the walls. In case the vein outcrops at the surface, any portion of such outcrop is the top, or apex. If the vein does not reach the surface, then the highest point to which the vein, or lode, can be traced is the apex—not necessarily the nearest point to the surface, but the absolute highest point. It is reasonable to believe that the top or apex was used instead of the word "outcrop," in order to cover "blind lodes," which do not crop out. The conception of an apex, which is properly a point, was probably taken from the appearance of a blind lode in a cross-section, where the walls appear as lines and the upper edge as a point. The term may also have been intended to cover the imaginary case of an ore deposit that terminates upward in a point. We may, however, dismiss from consideration the case of a simple point, and safely assume that the apex is the same as a top, and is either a line or a surface (Raymond).

The top or apex of a vein, within the meaning of the law, is the highest point of such vein where it approaches nearest to the surface of the earth, and where it is broken on its edge so as to appear to be the beginning or the end of the vein. (Stevens *v.* Williams, 23 Federal Cas., p. 46.)

The top or apex of a vein or lode is the end or edge or terminal of such vein or lode nearest the surface of the earth. It is not necessary that it should be on or near or within any given distance of the surface, but if found at any depth and the locator can define on the surface the area that will enclose it, then the vein or lode may be held by such location. (Iron Silver Min. Co. *v.* Murphy, 3 Federal, p. 373.)

The apex or top of a vein is the point where it ceases to continue in the direction of the surface. (Sloss-Sheffield Steel and Iron Co. *v.* Payne, 64 Southern, 617.)

The apex of a vein or lode is not necessarily a point, but may be a line of great length, and if a portion is found within the limits of a claim it is a sufficient discovery to enable the locator to obtain title. (Poplar Creek Consol. Quartz Mine, In re, 16 Land Decisions, p. 2; Larkin v. Upton, 144 U. S., p. 20; Debney v. Iles, 3 Alaska, p. 451.)

An apex of a vein is that part or portion of the terminal edge of a vein from which the vein has extension downward in the direction of the dip and the definition involves the elements of terminal edge and downward course therefrom. (Stuart Min. Co. *v.* Ontario Min. Co., 237 U. S., p. 360.)

(Additional cases are cited in U. S. Min. Stat., p. 105.)

Aphanite. An old name, now practically obsolete, for dense dark rocks, whose components are too small to be distinguished with the eye. It was chiefly applied to finely crystalline diabases. An adjective, aphanitic, is still more or less in current usage. (Kemp)

Aphanitic. Having a texture so fine that the individual grains or crystals can not be distinguished with the naked eye. (Ransome)

Aphanophyric. Containing phenocrysts in an aphanitic groundmass; said of some porphyritic igneous rocks. (La Forge)

Aphrite. A foliated or scaly white pearly calcite. Called also Earth foam and Foam spar. (Standard)

Aphrizite. A black variety of tourmaline. (Standard)

Aphrodite. A hydrous silicate of magnesium, in appearance much like meerschaum. (Chester)

Aphrosiderite. A chlorite-like mineral of scaly structure and olive-green color, near penninite in composition. (Chester)

Aphthitalite. A white saline potassium-sodium sulphate, $(K\,Na)_2\,SO_4$, crystallizing in the rhombohedral system. (Dana)

Aphthonite. A steel-gray argentiferous variety of tetrahedrite. (Standard)

Apilar (Sp.). To form a heap or pile. (Halse)

A pique (Mex.). Vertical. (Dwight)

Apique (Colom.). 1. Shaft. 2. Winze. 3. In alluvial mines, the point where the pump is placed. (Halse)

Apireo (Chile). Transporting ore on men's shoulders. *See also* Hapire. (Halse)

Apires (Peru). Ore carriers in mines. (Dwight)

Aplanador (Sp.). 1. A blacksmith's flatter. (Dwight)
2. An ingot hammer. 3. A riveter. (Halse)

Aplite. A term chiefly applied to finely crystalline muscovite-granite that occurs in dikes. Its original application was to granites poor or lacking mica. The name is from the Greek for simple. (Kemp)

Apo. The Greek preposition meaning 'from,' suggested by F. Bascom as a prefix to the names of various volcanic rocks to describe the devitrified or silicified varieties, that indicate their originals only by the preservation of characteristic textures, as apobsidian, aporhyolite, apobasalt, etc. Many rocks called by the old indefinite name petrosilex are of this character. (Kemp)

Apobsidian. Obsidian that has been devitrified by metamorphism. (Standard)

Apolvillado (Mex.). 1. Ore of a superior grade (Dwight)
2. A second-class ore from the Veta Madre, Guanajuato, Mex., yielding about 750 ounces of silver per short ton. (Halse)

Apophyllite. A calcium-hydrogen silicate sometimes containing potassium and fluorine, $K_2O.8CaO.16SiO_2.16H_2O$. Occasionally used as a gem. (U. S. Geol. Surv.)

Apophysis. A branch from a vein or dike to which it is attached; an epiphesis is the same, but not attached. (Min. and Sci. Press, vol. 116, p. 694)

Aporhyolite. Rhyolite that has been more or less devitrified by metamorphism. (Standard)

Aporreador (Chile). A sledge hammer; a maul. (Halse)

Appalachian. Of, or pertaining to, a system of mountains in the eastern United States, also incorrectly called Allegheny from its western range. (Webster)

Appalachian coal field. The coal-producing area extending from northern Pennsylvania to Alabama in and adjacent to the Appalachian mountains.

Apparatus (No. of Eng.). 1. The screening appliances upon the pit bank (at or near a mine). (Gresley)
2. Any complex device or machine designed or prepared for the accomplishment of a special purpose; also a collection of tools, appliances, materials, etc., as that necessary to the pursuit of a profession, as surgical or chemical apparatus. (Standard)

Apparent superposition. The actual or visible order in which strata lie in any locality. (Standard)

Apple coal (Scot.). *See* Yolk coal.

Appliances of transportation. As applied to a coal mine, these include the motor tracks, roadbed, cars, and motors used for the removal of coal from the mine. (Jaggie *v.* Davis Colliery Co., 84 Southwestern, p. 941)

Appolt oven. An oven for the manufacture of coke, differing from the Belgian in that it is divided into vertical compartments. (Raymond)

Approved. Accepted as suitable by a competent committee, board, or organization designated by those adopting the rules. (H. H. Clark) Applies to permissible explosives, safety lamps, motors, etc., as passed upon by the Bureau of Mines.

Apron. 1. A canvas-covered frame set at such an angle in the miner's rocker that the gravel and water in passing over it are carried to the head of the machine. 2. An amalgamated copper plate placed below the stamp battery, over which the pulp passes. The free gold contained in the pulp is caught by the quicksilver on the plate (Hanks). *See also* Copper plates.
3. A hinged extension of a loading chute. Commonly called Lip in Arkansas. (Steel)
4. A broad shallow vat for evaporating. 5. A receptacle for conveying rock by means of a cable-way and trolley. 6. An endless belt for conveying material of any kind; called also a Traveling apron. 7. A shield of planking, brushwood, or other material, below a dam, along a seawall, etc. (Webster)
8. A sheet of sand and gravel lying for some distance in front of the terminal moraines of a glacier. Called also Frontal apron and Morainal apron. (Standard)

Apron plate. The large amalgamated plate, of copper or silvered copper, that receives the discharge from a stamp mill, or other crushing or screening apparatus, but sometimes placed in a separate building.

Apron roll. One of the rolls that carries a traveling apron. (Webster)

Apurador (Mex.). 1. One who looks for particles of ore in waste waters.
2. Men who rewash the ore from the *tinas*, or *patio* process. (Halse)

Apuradora (Sp.). 1. Long drills used in finishing a borehole. 2. A large vat used in the *patio* process in which the *bateas* are washed. (Halse)

Apurar; Purificar (Sp.). 1. To purify metals. 2. To clean up ores. 3. To consume. (Halse)

Apuro (Sp.). A cast-iron settling pot used in the *patio* process. (Halse)

Apyrous. Not changed by extreme heat, as mica: distinguished from Refractory. (Standard)

Aqua fortis. Nitric acid. Applied especially to the weaker grade of the commercial acid. (Webster)

Aquamarine. A transparent, light bluish-green beryl. Used as a gem. (U. S. Geol. Surv.)

Aqua regia. A mixture of nitric and hydrochloric acids. By the action of the chlorine evolved it dissolves gold or platinum. (Webster)

Aqueduct. An artificial elevated way for carrying water. (C. and M. M. P.)

Aqueo-glacial. Of, or pertaining to, or resulting from, the combined action of ice and water. (Webster)

Aqueo-igneous. Of, or pertaining to, or resulting from the joint influence of heat and water. (Webster)

Aqueous fusion. Melting in the water of crystallization. (Webster)

Aqueous lava. The mud lava formed by the mixture of volcanic ash with condensing volcanic vapor or other water. (Standard)

Aqueous rocks. Sedimentary rocks. *See also* Sedimentary.

Aquifer. A porous rock stratum that carries water. (Lowe)

Aquilatar (Sp.). *See* Quilatar.

Aragonite. Orthorhombic calcium carbonate, $CaCO_3$. *See also* Calcite. (Dana)

Aragonite group. Aragonite, bromlite, witherite, strontianite, and cerusite. (Standard)

Aragotite. A peculiar kind of bitumen found in the Sulphur Springs district of California, and also in the quicksilver mines of Lake, Yolo and Santa Clara counties, in the same State. Not to be confused with Aragonite. (Mitzakis)

Aralo-Caspian. In physical geography, a term applied to the extensive basin or depressed area occupied by the Aral and Caspian Seas, and which is a true "basin of continental streams," having no communication with the ocean. (Page)

Arancel (Peru). A list of fees payable to Government engineers, for surveying, marking out boundaries, etc. (Halse)

Arborescent. Applied to minerals when assuming a tree-like form, more especially when fairly massive; if so thin as to resemble the painting of a tree they are generally termed Dendrites. (Power)

Arcanite. Same as Aphthitalite. (Dana)

Arch. 1. (Corn.) A portion of a lode left standing when the rest is extracted, to support the hanging wall or because it is too poor for profitable extraction. (Raymond). Ground unworked near a shaft. (Bainbridge)
2. One of the fire chambers of a brick kiln; also the fire chamber in certain kinds of furnaces and ovens, from the arched roof. (Webster)
3. The roof of a reverberatory furnace. (Raymond)

Archæan; Archean. Ancient. The term is sometimes used as the equivalent of Pre-Cambrian, but is restricted by the U. S. Geol. Surv. and most American geologists to the oldest stratified rocks.

Arch brick. 1. Commonly applied to those brick taken from the arches of a kiln. They are usually overburned. (Ries)
2. A wedge-shaped brick used in building an arch. (Webster)

Arched (Corn.). Said of the roads in a mine, when built with stones or bricks. (Min. Jour.)

Archemy. A variant of Alchemy. (Century)

Archeozoic. 1. The era during which, or during the later part of which, the oldest system of rocks was made. (Chamberlin)
2. Belonging to the last of three subdivisions of Archean time, when the lowest forms of life probably existed. (Standard)

Archetto (It.). A wire stretched on a forked or bent stick for smoothing potter's clay in molding. (Standard)

Archimedean screw. A spiral screw, fitting closely in a tube, for raising water or other liquids; often used as a screw conveyor for grain, sand, gravel, and fine ore.

Archimedes limestone. One of the subordinate beds of the lower Carboniferous series. (Emmons, 1860)

Arching (Eng.). Brickwork or stonework forming the roof of any underground roadway. (Gresley)

Archolithic. Of or pertaining to the earliest sedimentary rocks, as the Laurenthian and Silurian. (Standard). The term is not in common usage.

Arcilla (Mex.). Clay (Dwight). Kaolin.

Arcilloso (Mex.). Argillaceous. (Dwight)

Arcose. Same as Arkose. (Standard)

Arc welding. *See* Electric welding.

Ardennite. A yellow to yellowish-brown vanadio-silicate of aluminum and manganese that crystallizes in the orthorhombic system. (Dana)

Área (Sp.). A square of 10 meters on each side, equivalent to about 143 sq. *varas*. (Halse)

Areal geology. That branch of geology which pertains to the distribution, position, and form of the areas of the earth's surface occupied by different sorts of rock or different geologic formations, and to the making of geologic maps. (La Forge)

Areia (Port.). Sand, gravel; *A. movediça*, quicksand; *A. preta*, black sand (Halse). *Compare* Arena.

Arena (Sp.) Sand or grit; *A. de oro*, gold-bearing sand; *A gorda*, coarse sand or gravel. (Halse)

Arenaceous. An adjective applied to rocks that have been derived from sand or that contain sand. (Kemp) Not to be confounded with siliceous.

Arendalite. A dark-green crystalline epidote. (Standard)

Areng (Borneo). A yellowish gravelly earth, sometimes containing diamonds. (Lock)

Arenilitic. Of or pertaining to sandstone. (Standard)

Arenilla. 1. (Sp.) Fine sand. 2. (Venez.) Black, magnetic-iron sand. 3. (Colom.) Titaniferous iron ore. 4. (Chile) Copper matte mixed with slag; also specular iron ore. (Halse) 5 (Mex.). Tailings; refuse earth. (Dwight)

Arenisca (*piedra arenisca*) (Mex.). Sandstone. (Dwight)

Arenose. Full of grit or fine sand; gritty. (Standard)

Arenoso (Sp.). Sandy; gravelly; gritty. (Vel.)

Areometer. An instrument for measuring the specific gravity of liquids; a hydrometer. (Standard)

Arents tap. An arrangement by which the molten lead from the crucible of a shaft furnace is drawn through an inverted siphon into an exterior basin, from which it can be ladled without disturbing the furnace. (Raymond)

Arfvedsonite. A slightly basic metasilicate of sodium, calcium, and ferrous iron. One of the amphibole group. (Dana)

Argal. *See* Argol.

Argall furnace. A reverberatory roasting furnace of which the hearth has a reciprocating movement whereby the ore is caused to move forward by the action of rabbles extending across the hearth. (Ingalls, p. 116.)

Argall tubular furnace. A tubular roasting furnace consisting of 4 brick-lined steel tubes 30 feet long nested together inside two steel tires, which revolve upon steel-faced carrying rolls. (Ingalls, p. 121.)

Argamasa. 1. (Sp.). Lime mortar. (Dwight)
2. *A. hidráulica*, cement mortar or hydraulic cement. 3. (Sonora, Mex.) A cement gravel, or conglomerate containing mica, hematite, black sand, and quartz cemented with calcite. (Halse)

Argental mercury. A silver amalgam. (Standard)

Argentiferous. Containing silver.

Argentina. In ceramics, unglazed porcelain coated by a chemical process with gold, silver, or copper. (Standard)

Argentine. 1. A lamellar variety of calcite with a pearly white luster. (Chester)
2. Silver-coated white metal. 3. A finely divided tin moss or sponge obtained from a solution of tin by precipitation with zinc. (Standard)

Argentine flowers of antimony. The tetroxide of antimony. (Century)

Argentite; Silver glance. A silver sulphide, Ag_2S. Contains 87 per cent silver. (U. S. Geol. Surv.)

Argentopyrite. A silver and iron sulphide occurring in small hexagonal prisms. (Chester)

Argentum (L.). Silver, the chemical symbol of which is Ag.

Argil. 1. Potters' clay; white clay. 2. Same as Aluminite. (Standard)

Argile plastique (Fr.). A clay near the base of the Tertiary system in France; used for pottery purposes. (Page)

Argillaceous. Containing clay, either soft or hardened, as in shale, slate, argillite, etc.; applied to minerals having the odor of moistened clay.

Argillaceous sandstone. A sandstone containing a considerable proportion of clay. (Bowles)

Argillite. 1. A thick-bedded argillaceous sedimentary rock without distinct slaty cleavage or shaly fracture; mudrock: sometimes called Pelite. 2. A clay slate: in this sense a metamorphic rock with true slaty cleavage. The term is probably more generally used in the first sense in the United States and in the second sense abroad. (La Forge)

Argillo-arenaceous. Composed of or containing clay and sand. (Standard)

Argillo-calcareous. Composed of or containing clay and lime. (Standard)

Argillo-calcite. A clayey calcite. (Standard)

Argillo-ferruginous. Composed of or containing clay and iron. (Standard)

Argillo-magnesian. Composed of or containing clay and magnesia or magnesium. (Standard)

Argirosa (Sp.). Dark ruby silver. (Halse)

Argol. Unrefined or crude tartar. A hard crust of potassium bitartrate formed on the sides of vessels in which wine has been fermented. Also written, Argal, Argoll, Argall, Orgal (Century). Used extensively in assaying for its reducing power.

Argon. A colorless odorless gas in the air, of which it constitutes almost 1 per cent by volume. Symbol, A; atomic weight, 39.88. Specific gravity, 1.4. (Webster)

Argyrite. Same as Argentite. Also called Argyrose. (Standard)

Argyropyrite. A silver-iron sulphide $Ag_2Fe_7S_{11}$, similar to argentopyrite, that crystallizes in the hexagonal system (Standard). Probably the same as Argentopyrite.

Argyrose. Same as Argentite. (Standard)

Argyrythrose. Same as Pyrargyrite. (Standard)

Arid. Parched with heat; without moisture; very dry; barren; specifically, having little or no rainfall and requiring artificial irrigation. (Standard)

Ariegite. A name given by A. Lacroix to a special family of granitoid rocks, consisting primarily of monoclinic pyroxene and spinel. Subvarieties result from the presence of amphibole and garnet. The rocks are found in the French Pyrenees, in the department of Ariege, from which they take their name. They are most closely related to the pyroxenites. (Kemp)

Arista (Sp.). The intersection line of two planes. (Dwight)

Arite. A nickel mineral intermediate between niccolite and breithauptite. (Dana)

Arkansas stone. A true novaculite (*see* Novaculite) used as an oilstone for sharpening tools or instruments. Found in the Ozark Mountains of Arkansas. (Pike)

Arkansite. A variety of brookite from Magnet Cove, Arkansas. (Century)

Arkite. A name based on the common abbreviation Ark. for Arkansas, and given by H. S. Washington to a rock that occurs near the Diamond Jo quarry, Magnet Cove, Ark. The rock was earlier called leucite-porphyry, by J. F. Williams. (Kemp)

Arkose. 1. A sandstone rich in feldspar fragments, as distinguished from the more common richly quartzose varieties. (Kemp)
2. A sedimentary rock composed of material derived from the disintegration of granite, transported and redeposited with little sorting. (La Forge)

Arkosic. Having wholly or in part the character of arkose.

Arlequines (Mex.). Precious opals. (Lucas)

Arles, or Earles (No. of Eng.) Earnest money formerly allowed to colliers at the time of hiring them. (Gresley)

Arm. 1. The inclined member or leg of a set or frame of timber. (Raymond)
2. An inlet of water from the sea or other body of water. (Webster)

Armar (Mex.). To erect or fit up machinery, etc. (Dwight)

Armature. 1. A piece of soft iron or steel used to connect the poles of a magnet or of adjacent magnets. 2. That part of a dynamo-electric machine carrying the conductors whose relative movement through the magnetic field between the pole pieces causes an electric current to be induced in the conductors (as in a dynamo); or which by having a current passed through them are caused by electro-magnetic induction to move through this field (as in a motor). (Webster)

Armazón; Armadura (Sp.). Any framed structure, truss, trestle, etc. (Dwight)

Armenian stone. An old name for azurite, alluding to a locality in which it is found. (Chester)

Armenite (Armenia). A synonym for Azurite; Armenian stone. (Chester)

Aromatic compounds. Compounds derived from the hydrocarbon benzene (C_6H_6), distinguished from those derived from methane (CH_4). (Standard)

Aromatite. A bituminous stone resembling myrrh in color and odor. (Standard)

Arquerite (Chile). Silver amalgam, containing only a small proportion of mercury. (Chester)

Arrage. A sharp edge or corner in a drift. Called also Arris. (Standard)

Arranque (Sp.). Breaking ground, winning, or mining; *A. mecánico*, rock drilling by machinery; *A. trabajo*, a working place. (Halse)

Arrastrador (Mex.). Slag-pot puller. (Dwight)

Arrastrar (Mex.). 1. To drag along the ground; to haul or convey. 2. To unite as veins and form one. *A. el agua.* To remove the water from a sump or working. (Halse)

Arrastre (Sp.). 1. Apparatus for grinding and mixing ores by means of a heavy stone dragged around upon a circular bed. The arrastre is chiefly used for ores containing free gold, and amalgamation is combined with the grinding. Sometimes incorrectly written *arraster, arrastram*, or *raster* (Raymond). *A. de cuchara*, an arrastre driven by rough impact waterwheel, the blades of which are called *cucharas*. *A. de marca*, a large arrastre. *A. de mula*, mule-power arrastre. *A. de mano*, a hand arrastre for sampling purposes. 2. Haulage or conveyance. *A. interior*, underground haulage. 3. *A. de uncriadero*, footwall or floor of a deposit. (Halse)

Arrastrero. One who works an arrastre. (Halse)

Arreador; Arriero. 1. (Mex.) The mule driver on a hoisting whim. (Dwight)
2. (Bol.) A man who follows ore carriers to see that they do not steal ore. (Halse)

Arrebol (Mex.). The jerking of a rope as a signal to miners underground. (Dwight)

Arrested anticline. A term applied by Orton to a gentle monocline in the natural-gas fields of Ohio. (Ore Dep., p. 11)

Arriero (Mex.). Muleteer. (Dwight)

Arriñonada (Sp.). Botryoidal. (Dwight)

Arris. Same as Arrage.

Arris-cleat (Aust.). A strip of wood having a triangular cross-section used for keeping brattices in position. (Power)

Arroba (Mex.). Twenty-five pounds. (Dwight)

Arroyo (Sp.). A small stream, or its dry bed; in geology, a deep dry gully. (Standard)

Arrugia (Sp.). A deep gold mine. (Halse)

Arsenic. A solid brittle element of tin-white to steel-gray color and metallic luster, occuring free and also combined in various minerals. Symbol, As; atomic weight, 74.96. Specific gravity, 5.7. (Webster)

Arsénico (Sp.). Arsenic. (Dwight)

Arsenical nickel. A synonym for Niccolite.

Arsenical pyrite. A synonym for Arsenopyrite. (A. F. Rogers)

Arsenicite. Same as Pharmacolite. (Standard)

Arsenious. Pertaining to, or containing, arsenic; said of compounds in which arsenic is trivalent. (Webster)

Arsenite. Same as Arsenolite.

Arsenolamprite. A metallic lead-gray variety of native arsenic containing bismuth. (Standard)

Arsenolite. A white arsenious oxide, As_2O_3, with occasional yellow or red tinge, crystallizing in the isometric system. (Standard)

Arsenopyrite; Mispickel. A sulph-arsenide of iron, FeAsS. Contains 46 per cent arsenic, equivalent to 57.7 per cent white arsenic, As_2O_3. (U. S. Geol. Surv.)

Arsentine plate. German silver. (Standard)

Arshine (Russ.). A measure of volume equal to 12.7 cu. ft.

Arsine. Arseniureted hydrogen, AsH_3. (Standard)

Artesian. Of, or pertaining to Artois, anciently called Artesium, in France (Webster). *See also* Artesian well.

Artesian casing. *See* Screwed casing.

Artesian well. 1. A well bored down to a point, usually at great depth, where the water pressure, owing to the conformation of the strata, is so great as to force the water to the surface. 2. Often applied to any deep-bored well, even where pumping is necessary, as in an ordinary driven well. (Standard)

Artificial mineral. A mineral formed artificially, as in the laboratory, and so distinguished from one found in nature (Standard). A synthetic mineral.

Artificial soft porcelain. Porcelain with a body resembling glass consisting chiefly of alkaline salts and coated with a lead glaze, as the early tender porcelain of Sèvres. (Standard)

Artificial stone. A stony substance formed from certain basic natural materials which in the course of manufacture undergo chemical changes whereby an entirely new material is created. This new substance is then crushed, graded, molded into desired shapes and baked under intense heat in kilns or ovens. Often used as an abrasive. (Pike)

Aruppukarans. A gold-washing caste in Madras. (Lock)

Arvonian rock. A rock consisting of quartz-felsites, hälleflintas, and breccias, characteristic of the Cambrian or an earlier period in Wales. (Standard)

Asbestiform. Formed like or resembling asbestos; fibrous: said of stones. (Standard)

Asbesto (Sp.). Asbestos; *A. leñoso*, ligniform asbestos; *A. de corcho*, mountain cork. (Halse)

Asbestos. White, gray, or green-gray fibrous variety of amphibole, usually one containing but little aluminum, as tremolite or actinolite; also, improperly, a fibrous serpentine or chrysotile. Called also Earth-flax, Mountain-cork, and Amianthus. (Standard)

Asbolite. An earthy manganese mineral (wad) containing oxide of cobalt, which sometimes amounts to 32 per cent. (Dana)

Ascendente (Sp.). Working upward. (Lucas)

Ascensional ventilation (Eng.). The arrangement of the ventilating currents so that the vitiated air shall rise continuously until reaching the surface. Particularly applicable to steep coal seams. (Gresley)

Ascension, infiltration by. The theory of infiltration by ascension in solution from below considers that ore-bearing solutions come from the heated zones of the earth, and that they rise through cavities, and at diminished temperatures and pressures deposit their burdens. (Ore Dep., p. 40)

Ascension theory. The theory that the matter filling fissure veins was introduced in solution from below. (Raymond)

Aschaffite. A name suggested by Gümbel for a dike rock occurring near Aschaffenburg, Bavaria. It is defined by Rosenbusch as a dioritic dike rock containing quartz and plagioclase, with biotite as the chief dark silicate. (Kemp)

Aschistic. A term applied by Brögger to dikes that are direct branches from larger intrusive masses and have essentially the same composition. (Daly, p. 39)

Asentador (Sp.). 1. A stonemason. 2. A settler used in ore dressing. (Halse)

Asentar el hoyo (Sp. Am.). To wash away the overburden. (Lucas)

Asentar planes (Colom.). To place dies or other resisting material below the stamps preliminary to crushing. (Halse)

Aserrador (Sp.). A sawyer. (Halse)

Aserrar (Sp.). To saw. (Dwight)

Asfalto (Sp.). Asphalt. (Dwight)

Ash; Volcanic ash. Tuff that in color, texture, and general appearance resembles ashes. (La Forge)

Ash-ball (Shrop). A mixture of small fragments of greenish clay, quartz, etc. (Gresley)

Ash-bed. A deposit of volcanic ash.

Ash-bed diabase. A rock on Keweenaw Point, Lake Superior, resembling a conglomerate, but which is interpreted by Wadsworth as a scoriaceous amygdaloidal sheet into which much sand was washed in its early history. (Kemp)

Ashes. The earthy or mineral part of combustible substances remaining after combustion, as of wood or coal. (Webster)

Ash furnace. A furnace or oven for fritting materials for glass making. (Webster)

Ashlar. 1. A block of stone, as brought from the quarry. 2. A squared stone. 3. Mason work of squared stones. (Standard)
4. A facing of cut stone applied to a backing of rubble or rough masonry or brickwork (C. and M. M. P.) Also called Bastard ashlar.
5. A thin brick made especially for facing walls. (Webster)

Ash oven. An ash furnace. (Standard)

Ash pit. The receptacle for ashes under a grate.

Ash's furnace. A furnace for refining spelter. (Ingalls, p. 571)

Asiderite. Daubree's name for stony meteorites that lack metallic iron. (Kemp)

Asiento (Mex.). 1. The concentrate in panning. 2. *A. mineral*, mineral region. (Dwight)

Asin (Philippines). Salt. (Standard)

Aslope (Corn.). In a slanting position. (Crofutt)

Asmanite. An orthorhombic variety of silica found in meteoric iron. (Standard)

Asombrarse (Sp.). Said of a lode when it varies its dip so as to become almost horizontal. (Lucas)

Aspa. 1. (Peru) Intersection or junction of two veins. (Dwight)
2. (Sp.). In gold milling, a tappet.
3. Two timbers in the form of a cross to operate an endless chain device for hoisting water. *See also* Noria, 1. (Halse)

Asparagus stone. A greenish-yellow variety of apatite. (Power)

Asperite. A collective name suggested by G. F. Becker for the rough cellular lavas whose chief feldspar is plagioclase, but of which it is impossible to speak more closely without microscopic determination. The name is intended for general field use much as trachyte was employed in former years. It is coined from the Latin word for rough. (Kemp)

Asperolite. A variety of chrysocolla, containing more than the usual percentage of water. (Chester)

Asperón (Mex.). Sandstone; Grindstone. (Dwight)

Asphalt. 1. A complex compound of various hydrocarbons, part of which are oxygenated. Related in origin to petroleum. Is brown or brownish black in color, melts at 90° to 100° F., and is mostly or wholly soluble in turpentine. *See also* Albertite, Elaterite, Gilsonite, Grahamite, Impsonite, Nigrite, Wurtzilite (U. S. Geol. Surv.). Also called Mineral pitch. Same as Asphaltum.
2. To cover or treat with asphalt.

Asphalt-base petroleum. Asphalt-base oils contain asphalt and no paraffin. They are distilled to asphalt, and the distillates are cut according to gravity; such oils do not yield steam-refined cylinder stock or paraffin wax. *See also* Paraffin-asphalt petroleum . (Bacon)

Asphalt-block pavement. A pavement having a wearing course of previously prepared blocks of asphaltic concrete. (Bacon)

Asphalt cement. A fluxed or unfluxed asphaltic material, especially prepared as to quality and consistency; suitable for direct use in the manufacture of asphaltic pavements. (Bacon)

Asphalted. Coated with asphalt. Usually Californian oil (which has an asphaltic base), coal tar, gilsonite or elaterite are added to give the right consistence to suit the average temperature that prevails when the coating is used. (Nat. Tube Co.)

Asphaltenes. The components of the bitumen in petroleum, petroleum products, malthas, asphalt cements, and solid native bitumens, that are soluble in carbon disulphide, but insoluble in naptha (petroleum spirit.) *See also* Petrolene. (Bacon)

Asphalt furnace. A portable furnace in which asphalt is heated for use in roofing, paving, etc. (Century.)

Asphaltic. Similar to, or essentially composed of, asphalt. (Bacon)

Asphaltic flux. *See* Flux, 2. The asphaltic flux is differentiated from paraffin flux and semi-asphaltic flux by a greater density, nearly that of water; by the absence of hard paraffin scale, and by the fact that the unsaturated hydrocarbons predominate. It yields a larger amount of ash-free residual coke on ignition than other fluxes. (Bacon)

Asphaltic sandstone. *See* Sandstone; Asphalt rock.

Asphaltite. A dark-colored, solid, difficultly fusible, naturally occurring hydrocarbon complex, insoluble in water, but more or less completely soluble in carbon disulphide, benzol, etc. (Bacon)

Asphalt rock. Asphalt stone. Limestone impregnated with asphalt (Webster). Also a term applied to asphaltic sandstone.

Asphalt stone. *See* Asphalt rock.

Asphaltum. *See* Asphalt, 1.

Aspirador (Mex.). An aspirator; an exhauster. (Halse)

Aspirail (Fr.). An opening for ventilation. (Davies)

Aspirator. An inhaler. (Standard)

Assay. 1. To test ores or minerals by chemical or blowpipe examination. To determine the proportion of metals in ores by smelting in the way appropriate to each. Gold and silver require an additional process called cupelling, for the purpose of separating them from the base metals. *See* Fire assay. 2. An examination of a mineral, an ore, or alloy differing from a complete analysis in that it determines only certain ingredients in the substance examined, whereas an analysis determines everything it contains.

Assay balance. A sensitive balance used in the assaying of gold, silver, etc., for weighing the beads, or prills. (Webster)

Assayer. One who performs assays.

Assay foot. The assay value multiplied by the number of feet across which the sample is taken. (H. C. Hoover, p. 10)

Assay inch. The assay value multiplied by the number of inches over which the sample was taken. (H. C. Hoover, p. 10)

Assay master. A chief or official assayer. (Standard)

Assay office (U. S.). A laboratory for examining ores, especially gold and silver ores, in order to determine their economic value. (Standard)

Assay pound. A small standard weight used in assaying bullion, etc., sometimes equaling a half gram, but varying with the assayer. (Webster)

Assay ton. A weight of 29.166+ grams used in assaying, for convenience. Since it bears the same relation to the milligram that a ton of 2000 pounds does to the troy ounce the weight in milligrams of precious metal obtained from the assay of an ore gives directly the number of ounces to the ton. (Webster)

Assay value. The amount of the gold or silver, in ounces per ton of ore, as shown by assay of any given sample. *Average assay value.* The weighted result obtained from a number of samples, by multiplying the assay value of each sample by the width or thickness of the ore face over which it is taken, and then dividing the sum of these products by the total width of cross section sampled. The result obtained would represent an average face sample.

Assessment. 1. The sum that the officers of a mining company levy on the stock held by shareholders. (Hanks)
2. *See* Assessment work.

Assessment work. The annual work upon an unpatented mining claim on the public domain necessary under the United States law for the maintenance of the possessory title thereto. Same as Annual labor. (Min. Stat., pp. 233-253)

Asta (Sp.). A shaft or spindle; *A. de bomba*, a pump rod; *A. de bandera*, flagstaff. (Halse)

Astatki; Ostatki. A Russian name for a petroleum residue now used as fuel. Until 1870 it was considered a useless article, and was disposed of by burning in open pits near the refineries. (Mitzakis)

Astel. Overhead boarding or arching in a mine gallery. (Raymond)

Asteriated quartz. A phenocrystalline variety of quartz having whitish or colored radiations within the crystals: called also Star-quartz. (Standard)

Asterism. The name given to the peculiar starlike rays of light observed in certain directions in some minerals. (Dana)

Astiaes (Port.). The sides or walls of an oven. (Halse)

Astillero (Mex.). A place in a forest where firewood is cut; an open forest; a pasture for mules, etc. (Halse)

Astral. 1. The stage in earth growth when it glowed with incandescent heat, like a star. (Lowe) 2. Pertaining to the earliest of three subdivisions of Archean time, that of the fluid globe surrounded by a heavy vaporous envelope. (Standard) Now obsolete.

Astraline. A Russian petroleum product possessing the specific gravity 0.850–0.860, a flash point not less than 50° C. (122° F.), and of a pale yellowish color. (Bacon)

A-stretching (Scot.). In the line of the strike of the strata; level course. (Barrowman)

Astringent. A taste that puckers the mouth (George). Said of certain minerals.

Astyllen. 1. (Corn.) A mine stopping to prevent the flow of water; a dam. 2. A wall to separate ore from waste. (Pryce)

Asymmetrical. 1. Without proper proportion of parts; unsymmetrical. 2. Crystals not divisible into similar halves by a plane; triclinic (Standard). Also used in geology in describing structural features.

Asymmetric class. The class of crystal forms without any symmetry. (A. F. Rogers)

Asymmetric dispersion. The dispersion that produces an interference figure without any symmetry of color distribution. (A. F. Rogers)

Atacadero (Sp.). A rammer; a tamping bar. (Halse)

Atacamite. A basic chloride of copper, $Cu_2ClH_3O_3$, containing 59.4 per cent copper (Dana). Also called Green sand of Peru. (Chester)

Atacar (Peru). To tamp. (Mex.). To express mercury from a canvas bag by beating it with a stick. (Dwight)

Atajador (Sp.). A boy who attends the mules, horses, or burros; a hostler. (Crofutt)

Ataje (Colom.). A natural obstruction that diverts water from its regular channel. (Halse)

Ataques (Mex.). Rubbish. (Dwight)

Atecas (Mex.). Men who carry water from the bottom workings of a mine, by use of bags or buckets, to a sump from which it can be pumped to the surface. (Halse)

Atelene. Lacking the essential form; imperfect (Standard). Said of crystals.

Atelestite. A sulphur-yellow adamantine bismuth arsenate. $H_3Bi_2AsO_8$, crystallizing in the monoclinic system. (Standard)

Atelite. A green copper hydroxychloride, $H_6Cu_3O_6Cl_2$, found near volcanoes. (Standard)

Aterrar (Port.). To fill with waste; to pack. (Halse)

Aterro (Port.). Attle; waste rock. (Halse)

Atierres (Mex.). Waste rock in a mine. (Dwight)

Atincar (Sp.). Refined tincal; borax of commerce. (Halse)

Atinconar (Sp.) To secure the walls provisionally with stulls. (Halse)

Atiz (Colom.). Poles for lagging. (Halse)

Atizador (Sp.). 1. A man who attends the furnace; a stoker. 2. A dresser of *magistral*. 3. (Colom.) A battery feeder. (Halse)

Atlasite. A cupric carbonate containing chlorine. Probably a mixture of atacamite and azurite. (Standard)

Atmosphere. 1. The whole mass of air surrounding the earth. 2. The pressure of air at the sea level used as a unit. *See also* Atmospheric pressure. (Webster)

Atmospheric pressure. The pressure of air at the sea level, exerted equally in all directions. The standard pressure is that under which the mercury barometer stands at 760 millimeters. It is equivalent to about 14.7 pounds to the square inch. (Webster)

Atoll. A coral island of circular form, inclosing a lagoon.

Atom. According to the atomic theory, the smallest particle of an element that can exist either alone or in combination with similar particles of the same or of a different element; the smallest particle of an element that enters into the composition of a molecule. (Webster)

Atomic weight. The weight of an atom of a chemical element as compared with that of an atom of hydrogen. (Standard)

INTERNATIONAL ATOMIC WEIGHTS, 1918.

On account of the difficulties of correspondence between its members, due to the war, the International Committee on Atomic Weights has decided to make no full report for 1918. Although a good number of new determinations have been published during the past year, none of them seems to demand any immediate change in the table for 1917. That table, therefore, may stand as official during the year 1918.

F. W. CLARKE, *Chairman.*

	Symbol.	Atomic weight.
Aluminum	Al	27.1
Antimony	Sb	120.2
Argon	A	39.88
Arsenic	As	74.96
Barium	Ba	137.37
Bismuth	Bi	208.0
Boron	B	11.0
Bromine	Br	79.92
Cadmium	Cd	112.40
Caesium	Cs	132.81
Calcium	Ca	40.07
Carbon	C	12.005
Cerium	Ce	140.25
Chlorine	Cl	35.46
Chromium	Cr	52.0
Cobalt	Co	58.97
Columbium	Cb	93.1
Copper	Cu	63.57
Dysprosium	Dy	162.5
Erbium	Er	167.7
Europium	Eu	152.0
Fluorine	F	19.0
Gadolinium	Gd	157.3
Gallium	Ga	69.9
Germanium	Ge	72.5
Glucinum	Gl	9.1
Gold	Au	197.2
Helium	He	4.00
Holmium	Ho	163.5
Hydrogen	H	1.008
Indium	In	114.8
Iodine	I	126.92
Iridium	Ir	193.1
Iron	Fe	55.84
Krypton	Kr	82.92
Lanthanum	La	139.0
Lead	Pb	207.20
Lithium	Li	6.94
Lutecium	Lu	175.0
Magnesium	Mg	24.32
Manganese	Mn	54.93
Mercury	Hg	200.6
Molybdenum	Mo	96.0
Neodymium	Nd	144.3
Neon	Ne	20.2
Nickel	Ni	58.68
Niton (radium emanation)	Nt	222.4
Nitrogen	N	14.01
Osmium	Os	190.9
Oxygen	O	16.00
Palladium	Pd	106.7
Phosphorus	P	31.04
Platinum	Pt	195.2
Potassium	K	39.10
Praseodymium	Pr	140.9
Radium	Ra	226.0
Rhodium	Rh	102.9
Rubidium	Rb	85.45
Ruthenium	Ru	101.7
Samarium	Sa	150.4
Scandium	Sc	44.1
Selenium	Se	79.2
Silicon	Si	28.3
Silver	Ag	107.88
Sodium	Na	23.00
Strontium	Sr	87.63
Sulphur	S	32.06
Tantalum	Ta	181.5
Tellurium	Te	127.5
Terbium	Tb	159.2
Thallium	Tl	204.0
Thorium	Th	232.4
Thulium	Tm	168.5
Tin	Sn	118.7
Titanium	Ti	48.1
Tungsten	W	184.0
Uranium	U	238.2
Vanadium	V	51.0
Xeno	Xe	130.2
Ytterbium (Neoytterbium)	Yb	173.5
Yttrium	Yt	88.7
Zinc	Zn	65.37
Zirconium	Zr	90.6

Atomization. 1. The method by which a jet of steam, or compressed air, is made to finely divide a fluid, as in an oil-burning furnace.
2. A patent process for producing a metallic dust, as zinc dust.

Atomizer. An apparatus for converting liquid into spray. *See also* Atomization.

Atrancar (Mex.). To drill (for blasting) at a very acute angle. (Dwight)

Attal. *See* Attle.

Attle; Attal. 1. (Corn.) Rubbish; rock containing too little ore to be worth working. (Whitney)
2. (No. of Eng.) To arrange or settle, as an account. (Gresley)

Atreol. A petroleum product produced by the action of sulphuric acid on certain petroleum distillates. Properly refined and combined with ammonia, it produces the active principle of atreol,—ammonium atreolate. It is soluble in water and alcohol, and is miscible with petroleum and lanolin.

Attrition. Act of rubbing together; friction; act of wearing, or state of being worn; abrasion. (Webster)

Aturdir (Mex.). To subdivide, mechanically, the quicksilver in a *torta* so as to quicken its action upon the mineral treated. (Dwight)

Auerlite. A silico-phosphate of thorium containing about 70 per cent thorium. Like zircon in form. (U. S. Geol. Surv.)

Aufre (Sp. Am.). A very hard yellow stone; sulphur-like rock. (Lucas)

Augen. The German word for eyes; used as a prefix before various rock names, but more especially gneiss, to describe larger minerals or aggregates of minerals, that are in contrast with the rest of the rock. In the gneisses, feldspar commonly forms the augen. They are lenticular with the laminations forking around them, in a way strongly suggesting an eye. The term is seldom used in any other connection than with gneiss in America. (Kemp)

Auger. An instrument for boring or perforating soils or rocks. A carpenter's tool for boring wood (Webster). A tool for drilling holes in coal for blasting.

Auger machine. A machine for the manufacture of zinc-distillation retorts. Similar to machines used for manufacturing drain pipes. (Ingalls, p. 234)

Auger-nose shell (Eng.). A clearing tool used in boring for coal, etc., having an auger-shaped end (Gresley). *See also* Wimble.

Auger stem. The iron rod to which the bit is attached in well drilling. (Standard)

Auger-stem guides. *See* Sinker-bar guides.

Auget; Augette. A priming tube, used in blasting. (Raymond)

Augite. The commonest rock-making pyroxene. As distinguished from other pyroxenes augite refers to the dark varieties with considerable alumina and iron. The name is used as a descriptive prefix to many rocks that contain the mineral, as for instance augite-andesite, augite-diorite, augite-gneiss, augite-granite, augite-syenite, etc. (Kemp)

Augitite. Non-feldspathic, porphyritic rocks consisting essentially of a glassy groundmass, with disseminated augite and magnetite. Various minor accessories also occur. (Kemp)

Augitophyric. In petrology, containing distinct crystals of augite. (Standard)

Augustin process. The treatment of silver ores by chloridizing roasting, lixiviation with hot brine, and precipitation on copper. (Raymond)

Aumento (Bol.). In the *patio* process, the apparent increase in the amount of mercury used when treating ores containing a large percentage of silver; in reality due to loss of mercury. (Halse)

Auquis (Peru). Rock drillers in mines. (Dwight)

Auralite. Altered iolite. (Standard)

Aureola azul (Sp.). The blue cap or halo of a candle or lamp in an atmosphere containing fire damp. (Halse)

Aureole. The area that is affected by contact metamorphism around an igneous intrusion. (Kemp)

Auri-argentiferous. Containing both gold and silver; applied to minerals. (Standard)

Auric. Of, pertaining to, or containtaining gold, especially when combined in its highest or triad valency, as auric chloride, $AuCl_3$. (Standard)

Aurichalcite. A basic carbonate of zinc and copper, $2(Zn,Cu)CO_3 \cdot 3(Zn,Cu)(OH)_2$. (Dana)

Aurifero (Sp.). Gold-bearing. (Dwight)

Auriferous. Containing gold.

Auriferous pyrites. Pyrite containing gold. (Standard)

Aurigerous. Gold-bearing; auriferous. (Standard)

Aureral. Of, pertaining to, or designating the second group of Paleozoic strata in the Lower Silurian of the original system of the Pennsylvania Survey (Standard). Now obsolete.

Aurum. Gold. Its chemical symbol is Au.

Ausscharen (Ger.). The junction of lodes. (Davies)

Austrian vermilion. A basic chromate of lead. (Webster)

Auszimmern (Ger.). Timbering. (Davies)

Authigenous. An adjective coined by Kalkowsky to describe those minerals which form in sediments after their deposition, as, for instance, during metamorphism. The name emphasizes in its etymology the local origin of the minerals as contrasted with that of the other components, the latter having been brought from a distance. (Kemp)

Authigenic. Produced where found; said of the ingredients of crystalline rocks, or of crystalline ingredients of rocks. (Standard)

Autochthonous. An adjective derived from two Greek words, meaning indigenous. It is applied to those rocks that have originated *in situ*, such as rock salt, stalagmitic limestones, peat, etc., but it is of rare use. (Kemp)

Autoclastic. Having a clastic or fragmental structure due to crushing or to dynamic metamorphism instead of to sedimentation: said of intraformational conglomerates. (La Forge)

Autogenetic drainage. Drainage due to erosion caused by the waters of the constituent streams. (Standard)

Autogenetic topography. Conformation of land due to the physical action of rain and streams. (Standard)

Autogenic soldering. The process of uniting pieces of metal by merely fusing them together. (Webster)

Automatic mine-doors. Doors on a haulage road that are automatically opened by an approaching trip passing over a lever, and that close automatically after the trip has passed through, thus making the services of a door- or trapper-boy unnecessary.

Automorphic. The contrasted term with xenomorphic or allotriomorphic, and is used to describe those minerals in rocks which have their own crystal boundaries. The later suggested word, idiomorphic, means the same thing and is somewhat more widely used. (Kemp)

Autunite. Calcium uranite. A hydrous phosphate of uranium and calcium, $Ca(UO_2)_2P_2O_8+8H_2O$. Contains 62.7 per cent UO_3, equivalent to 61.6 per cent U_3O_8 (Dana). The mineral is radioactive.

Autun shale oil. A name applied to a certain kind of illuminating oil, so called through being extracted from the bituminous shale found at Autun in France. (Mitzakis)

Avalanches. 1. Masses of snow, that being detached from great heights in the mountains, acquire enormous bulk by fresh accumulations as they descend; and when they fall into the valleys below, often cause great destruction. (Davies)
2. Falling masses of rock and earth, sometimes called avalanches, are better designated landslides. (Standard)

Avalite. An impure variety of muscovite containing chromium oxide. (Standard)

Avanco (Port.). The main level following the strike. (Halse)

Avasite. A black, massive, hydrated iron silicate: probably only siliceous limonite. (Standard)

Avena (Sp.). Oats. (Dwight)

Aventadero. 1. (Sp. Am.) A slide of loose ground containing alluvial gold. (Lucas)
2. (Colom.) A placer higher than a *sabana*. 3. (Peru) An auriferous deposit or placer. (Halse)

Aventurine. 1. A kind of glass containing gold-colored spangles. 2. A variety of translucent quartz, spangled throughout with scales of mica or other mineral. (Webster)
3. A variety of feldspar containing shining particles. (Standard)

Aventurine feldspar. A name for sunstone, which may be orthoclase, albite, or oligoclase (Chester). Dana confines this term to the oligoclase variety.

Aventurine quartz. *See* Aventurine, 2.

Average clause (Eng.). A clause that, in granting leases of minerals (coal, ironstone, and clay in particular), provides that lessees may, during every year of the term, make up any deficiency in the quantity of coal, etc., stipulated to be worked, so as to balance the dead or minimum rent. (Gresley)

Average igneous rock. According to Clarke, the arithmetic mean of all the good analyses should give a fair chemical average for the outermost ten-mile shell of the earth, which represents the composition of an average igneous rock. Authorities differ somewhat from above manner of securing result. (Daly)

Average produce (Corn.). The quantity of pure or fine copper in one hundred parts of ore. (Raymond)

Average standard (Corn.). The price per ton of the fine copper in the ore, after deducting the charge for smelting. (Whitney)

Average weight (Eng.). The mean weight of a car of coal for a certain period, on which wages are calculated. (Bainbridge)

Avezacite. A name given by a Lacroix to a peculiar cataclastic rock found in veins or dikes in a peridotite at Avezac-Prat, in the French Pyrenees. The rock is dense, black, and brittle, but contains large basaltic hornblendes and yellow sphenes, in a fine-grained mass, which, on microscopic examination is resolved into a cataclastic aggregate of apatite, sphene, titaniferous magnetite, ilmenite, hornblende, augite, and rarely olivine and biotite. It is supposed to have resulted from the crushing of basic pegmatitic veins or dikes. (Kemp)

Aviado (Sp.). One who works a mine with means furnished by another. (Standard)

Aviador (Sp.). A person who habilitates a mine; that is, who furnishes the money for working it by a contract with proprietors. (Raymond)

Avio (Sp.). Operating funds furnished to the proprietors of a mine by another person, the *aviador*. *Contrato de avio*, a contract between two parties for working a mine by which one of the parties, the *aviador*, furnishes the money to the proprietors for working the mine. (C. and M. M. P.)

Avios (Sp.). Tools; implements. (Halse)

Aviso. 1. (Mex.). Announcement on a bulletin board, at the mining agency, of application for claims, etc. 2. (Colom.) Notice of a denouncement given before an *alcalde*. (Halse)

Avogadro's law. One of the fundamental chemical laws that equal volumes of all gases and vapors contain the same number of ultimate particles or molecules at the same temperature and pressure. (Liddell)

Avoirdupois. The system of weights used in England and the United States for the ordinary purposes of trade, of which the fundamental unit is the pound of 16 ounces or 7,000 grains (Standard). The avoirdupois pound is equivalent to 14.583 troy ounces, 453.6 grains, and has a fine-gold value of $301.4375 or £61.97.

Avulsion. A sudden change in the course of a stream by which a portion of land is cut off, as where a river cuts across, forming an "Ox bow." (Shamel, p. 307)

Award (Forest of Dean). A grant or lease of certain minerals. *See also* Gale, 1. (Gresley)

Awaruite. A native alloy of nickel and iron. It has the formula $FeNi_2$. (Dana)

Axe stone. A species of jade. It is a silicate of magnesia and alumina. (Duryee)

Axes of elasticity. Those axes in crystals that represent the directions of greatest, mean, and least indices of refraction. (Dana)

Axes of reference. Co-ordinate axes to which crystal faces are referred. (A. F. Rogers)

Axial angle. The angle between the two optic axes of a biaxial crystal. (Luquer, p. 5)

Axial elements. The axial ratio and the angles between the axes of a crystal. (A. F. Rogers)

Axial figure. *See* Interference figures.

Axial plane. 1. A crystallographic plane that includes two of the crystallographic axes. (Dana)
2. As applied to folds, is a plane that intersects the crest or trough in such a manner that the limbs or sides of the fold are more or less symmetrically arranged with reference to it. (Leith)

Axial ratio. The ratio obtained by comparing the length of a crystallographic axis with one of the lateral axes taken as unity. (Dana)

Axinite. A boro-silicate of aluminum and calcium with varying amounts of iron and manganese. Exact composition doubtful. (Dana)

Axiolite. A term coined by Zirkel in his report on Microscopical Petrography, for the U. S. Geol. Survey along the Fortieth Parallel, 1876, to describe those spherulitic aggregates that are grouped around an axis rather than around a point. The application comes in microscopic work rather than in ordinary determination. *Compare* Spherulite. (Kemp)

Axis. 1. A straight line, real or imaginary, passing through a body, on which it revolves or may be supposed to revolve; a line passing through a body or system around which the parts are symmetrically arranged. (Webster)
2. In crystallography, one of the imaginary lines in a crystal which are used as coordinate axes of reference in determining the positions and symbols of the crystal planes. (La Forge)
3. *See* Anticlinal axis, and Synclinal axis. Often used synonomously with anticlinal; thus the "Brady's bend axis" for Brady's bend anticlinal. (Chance)
4. In geology the central or dominating region of a mountain chain, or the line of which follows the crest of a range and thus indicates the position of the most conspicuous part of the uplift. (Century)

Axis of a crystal. *See* Axis, 1 and 2.

Axis of elevation. Line of elevation. (Hitchcock)

Axis of rotation. The imaginary line about which all the parts of a rotating body turn. (Century)

Axis of symmetry. An imaginary line in a crystal, about which it may be rotated a certain number of degrees so as to occupy the same position in space as before. (La Forge)

Axle. A transverse bar or shaft connecting the opposite wheels of a car or carriage. (Webster)

Axletree. An axle made of wood; the center shaft of a horse gin. (Barrowman)

Axman; Axeman. In surface surveying, one who clears the ground and drives the stakes for the rodman. (Standard)

Axotomous. In crystallography, having cleavage perpendicular to an axis: said of minerals. (Standard)

Ayate (Mex.). Coarse fiber-cloth for carrying ore, rock, etc. (Dwight)

Ayr stone. A fine-grained stone used in polishing marble and giving a fine surface to metal work, particularly iron and steel, also as a whetstone. Called also Scotch stone, Water of Ayr. (Standard)

Ayuda (Mex.). A small bonus to tributers who fail to make expenses (Dwight). *Metales de ayuda*, ore containing lead, used to assist in smelting other ore. (Halse)

Ayudante (Mex.). Assistant; *A. de fundición*, a master smelter. (Halse)

Azabache (Mex.). Jet. (Dwight)

Azadón (Sp.). Pick, mattock, hoe. (Vel.)

Azanca (Sp.). Subterranean spring. (Halse)

Azaracón (Sp.). Red lead; *A. nativo*, minium. (Halse)

Azimut (Mex.). Azimuth-bearing. (Dwight)

Azimuth. The azimuth of a body is that arc of the horizon that is included between the meridian circle at the given place and a vertical plane passing through the body. It is measured (in surveying) from due north around to the right (C. and M. M. P.). In astronomy it is measured from the south to the right *i. e.* clockwise.

Azimuth circle. An instrument for measuring azimuth, having for its chief characteristic a graduated horizontal circle. (Standard)

Azimuth compass. A magnetic compass supplied with sights, for measuring the angle that a line on the earth's surface, or the vertical circle through a heavenly body, makes with the magnetic meridian. (Standard)

Azogado (Mex.). Poisoned by mercury. (Dwight)

Azogue (Sp.). 1. Quicksilver. 2. Ore amenable to amalgamation; free milling ore. (Halse)
3. (Mex.). Common name for third-class silver ore, generally carrying 85 to 150 ounces per ton, which will pay for mining and shipping (Dwight). *A. apolvillado*, good ore suitable for amalgamation. *A. común*, common ore suitable for amalgamation. *A. en caldo*, quicksilver. *A. ordinario*, ordinary ore suitable for amalgamation. (Min. Jour.)

Azoguería (Sp.). 1. The amalgamating works. 2. The process of amalgamation. (Raymond)
3. A storehouse for quicksilver. (Dwight).

Azoguero. 1. (Mex.). The amalgamator, or person who superintends the process of amalgamation. 2. (Sp.) A dealer in quicksilver. (Halse)
3. (Mex.). The "mud-chemist" (also, the metallurgical foreman) in patio-annex. (Dwight)

Azogues. (Sp.). Common or inferior ores. (Raymond)

Azoic. Formerly, that part of geologic time represented by the pre-Cambrian stratified rocks; also the rocks formed during that time. Later restricted to the period and system now generally called Archean. Now practically obsolete. (La Forge)

Azorite. A synonym for Zircon.

Azotate. A nitrate. (Standard)

Azote. A name formerly given to nitrogen, because it is unfit for respiration. (Century)

Azoth. Mercury: the name given by the alchemists. (Standard)

Azotine. An explosive consisting of sodium nitrate, charcoal, sulphur and petroleum. (Webster)

Azotize. To nitrogenize. (Webster)

Azúcar (Colom.). A soft white granular rock in which calcite predominates, forming a gangue in which native gold occurs. (Halse)

Azuela (Mex.). Adze. (Dwight)

Azufrado. 1. (Colom.) A yellow ocher found in veins. (Halse)
2. In Peru, the general term *azufrados* is used for sulphide ores. (Dwight)

Azufral (Sp.). *See* Solfatara.

Azufre (Sp.). 1. Sulphur. *A. nativo*, native sulphur. 2. (Colom.). A yellow stone of great hardness frequently found in gold placers. (Halse)

Azufrón (Sp.). Pyritic mineral in a pulverulent condition. *Azufrones* (Mex.) Sulphide ores (Halse). *See also* Azufrado, 2.

Azulaque (Sp.). 1. Bitumen. 2. (Zacualpan, Mex.) Argentite. 3. *A. y cardenillo*, (Guerrero, Mex.) Copper ores of blue and green colors rich in silver. 4. *Azulaques* (Zacatecas, Mex.), ore derived from the country rock, which for some distance from the vein is impregnated with pyrite, argentite, silver, and chloride of silver (Halse). Finely disseminated ore. An impregnation of decomposed sulphides staining the gangue. (Dwight)

Azulinhas (Braz.). Small and cloudy sapphires found with diamonds. (Halse)

Azure spar. Lazulite. (Standard)

Azure stone. 1. A synonym for Lapis lazuli. (Power)
2. Same as Azurite. (Century)

Azurite. Blue copper carbonate, $CuCO_3.Cu(OH)_2$. Contains 46 per cent copper (U. S. Geol. Surv.). Sometimes called Azure stone.

Azurmalachite. A mixture of blue and green copper carbonates. (U. S. Geol. Surv.)

B.

Baaken (So. Afr.). A boundary mark. (Standard)

Babbitt metal. 1. A soft, white, anti-friction metal of varying composition, as of 4 parts of copper, 8 of antimony, and 24 or 96 of tin (the alloy with the smaller proportion of tin being called "hardening," that with the greater "lining"). 2. Any of several alloys similarly used. (Webster)

Babel quartz (Eng.). A variety of rock crystal, which from its fanciful resemblance to the successive tiers of the Tower of Babel, have given rise to the name. (Page)

Baboo; Babu (India). A native clerk who writes English. (Webster)

Baby (Eng.). A balance weight near the end of a pit (shaft) rope. (Bainbridge)

Bacharach-American gas indicator. A pocket device for the rapid determination of the percentage of CO_2 in the atmosphere of mines, boiler rooms, blast furnaces, etc.

Bacia (Port.). A basin, as of a river; *B. carbonifera*, a coal basin. (Halse)

Bacile (It.). In ceramics, a basin or deep dish of or resembling Italian enameled and lustered pottery. (Standard)

Bacino (It.). In ceramics, one of a class of dishes of highly colored pottery, built into the walls of medieval Italian buildings. (Standard)

Back. 1. That part of a lode which is nearest the surface in relation to any portion of the workings of the mine; thus the back of the level or stope is that part of the unstoped lode which is above. (Whitney)
2. A joint, usually a strike joint, perpendicular to the direction of working. 3. The upper surface of a beam. (Webster)
4. (Eng.) A plane of cleavage in coal, having frequently a smooth parting and some sooty coal included in it. 5. (Eng.) The inner end of a heading. 6. (Leic.) To throw back into the gob, or waste, the slack, dirt, etc., made in holing. 7. (Leic.) To roll large coal out of waste for loading into trams. (Gresley). Also called Backen.
8. To drive, force, or cause to move or act backward; to cause to retreat, or recede. (Webster). Also called Backen.

Back and underhand stoping milling system. *See* Combined and underhand stoping.

Back balance. 1. A kind of self-acting incline in a mine. A balance car is attached to one end of the rope, and a carriage for the mine car is attached to the other. A loaded car is run on the carriage and is lowered to the foot of the incline raising the balance car. The balance car in its descent raises the carriage when the carriage is loaded only with an empty car. 2. The means of maintaining tension on a rope transmission or haulage system, consisting of the tension carriage, attached weight, and supporting structure.

Backboard (York). Work, performed underground by the deputies, which consists of drawing timbers in abandoned or worked-out places, repairing brattices, doors, and keeping the roadways in order (Gresley). *See also* Backbye work.

Backbye work. Work done between the shaft and the working face, in contradistinction to face work, or work done at the face. (C. and M. M. P.) *See also* Back work.

Back casing (Eng.). A temporary shaft lining of bricks laid dry, and supported at intervals upon curbs. When the stonehead has been reached, the permanent masonry lining is built upon it inside of the back casing (Raymond). In the North of England the use of timber cribs and planking serves the same purpose.

Back coal (Scot.). Coal which miners are allowed to carry home. (Barrowman)

Back coming (Scot.). Working away the pillars which are left when mining coal inbye (Gresley). Robbing pillars; back working.

Backen (So. Staff.). *See* Back, 7 and 8.

Back end (Newc.). The part of a judd remaining after the *sump* (*See* Sump, 2.) has been removed. (Raymond)

Back entry. The air course parallel to and below an entry. *See also* Entry. (Steel)

Back fill. In engineering, to fill a depression with material taken from a cutting. (Century)

Back filling. 1. Rough material forming the back of a masonry wall. 2. The filling in again of a place from which the earth has been removed; the earth so filled in. (Century)

Back-filling system. *See* Overhand stoping; also Square-set stoping.

Back holes. In shaft sinking, raising or drifting, the round of holes which is shot last. (Du Pont)

Back horse (So. Staff.). The horse that draws the loaded skip from the loaders to the place (wagon hole) where the tramway ends. (Min. Jour.)

Backing. The timbers fixed across the top of a level, supported in notches cut in the rock. (Davies)

Backing deals (Eng.). Planks driven vertically behind the timbering in a shaft. (Chance)

Backjoint. 1. A joint plane more or less parallel to the strike of the cleavage, and frequently vertical. (C. and M. M. P.)
2. In masonry, a rabbet or chase left to receive a permanent slab or other filling. (Webster)

Backlash (Eng.) 1. The return or counterblast, as the recoil or backward suction of the air current produced after a mine explosion. (Gresley)
2. The reentry of air into a fan. (Steel)
3. The lost motion in gearing due to poorly fitting parts.

Back leads. A term applied to black sand "leads" on coast lines which are above high-water mark. (Duryee)

Back lye (Scot.). A siding or shunt on an underground tramway. (Gresley)

Back of a lode. The portion of a lode lying between a level driven in a lode and the surface (Davies). *See also* Back, 1.

Back of ore. The ore between two levels which has to be worked from the lower level (C. and M. M. P.). *See also* Back, 1.

Back overman (No. of Eng.). A man whose duty it is to look after the condition of underground workings and the safety of the men. (Gresley)

Back plate. The amalgamated plate inside and at the back of the mortar box of a stamp mill.

Back pressure. The loss, expressed in pounds per square inch, due to failure of getting the steam out of the cylinder after it has done its work. (Ihlseng)

Back-pressure valve. A valve similar to a low-pressure safety valve but capable of being opened independently of the pressure, thereby giving free exhaust. (Nat. Tube Co.)

Backs. The ore above any horizontal opening, such as a tunnel or drift (Duryee). *See* Back, 1.

Backs and cutters. Jointed rock structures, the backs (joints) of which run in lines parallel to the strike of the stratum, the cutters (cross joints) crossing them about at right angles. (Standard)

Backshift (No. of Eng.). A second shift or relay of miners who begin cutting coal after another set has begun to load it, at the same place. (Century)

Back shot. A shot used for widening an entry, placed at some distance from the head of an entry. (Steel)

Back sight. 1. The reading of a leveling staff in its unchanged position when the leveling instrument has been taken to a new position.
2. Any sight or bearing taken in a backward direction. (Webster)
3. An observation made for verification from one station to the one behind it; the converse of foresight. (Standard)
4. The rodman who indicates, by means of a range rod, leveling staff, or plumb line, the exact location of the backsight station. 5. Also the station sighted, and in plane-table triangulation, the line of the plane-table sheet by means of which the table is orientated by sighting back to the station from which the line was drawn as a foresight.

Back skin (Newc.). A leather covering worn by men in wet workings. (Raymond)

Back-slope. In geology, the less sloping side of a ridge. Contrasted with Escarpment, the steeper slope. Called also Structural plain. (Standard)

Back splinting (Scot.). A system of working a seam of coal over the goaf and across the packs of a lower seam taken out in advance by the long-wall method. (Gresley)

Backstay. A wrought-iron forked bar attached to the back of cars when ascending an inclined plane, which throws them off the rails if the rope or coupling breaks (C. and M. M. P.). *See also* Dragbar; Drag, 1.

Back stope. To mine a stope from working below. (Century)

Back stoping. *See* Overhand stoping; Shrinkage stoping.

Back switching. A zigzag arrangement of railway tracks by means of which it is possible for a train to reach a higher or lower level by a succession of easy grades (Bowles) *See also* Switchback.

Back-vent (Scot.). An aircourse alongside the pillar in wide rooms. (Barrowman)

Back work. 1. (Ark.) Loading coal, laying track, and other work of driving an entry and not done at the extreme face. (Steel) *See also* Backbye work.
2. (Scot.) *See* Back-coming, and Back splinting.

Backworking (Scot.). Working a coal bed back or toward a shaft. (Century)

Bacon stone. An old name for a variety of steatite, alluding to its greasy appearance. (Chester)

Bad air. Air vitiated by powder fumes, noxious gases or insufficient ventilation. (Weed)

Baddeleyite. Zirconium dioxide, ZrO_2.

Badlands. A region nearly devoid of vegetation where erosion, instead of carving hills and valleys of the ordinary type, has cut the land into an intricate maze of narrow ravines and sharp crests and pinnacles. Travel across such a region is almost impossible, hence the name. (U. S. Geol. Surv., Bull. 613, p. 182). Specifically, the Badlands of the Dakotas.

Bad place. Within the meaning of a contract between the United Mine Workers and an Employers' Association, a place in which the roof can not be made reasonably safe by the ordinary propping usually done by the miner. (Duncan Coal Co. v. Thompson, 162 Southwestern, p. 1140)

Baf ends (Eng.). Long wooden wedges for adjusting linings in sinking shafts. (C. and M. M. P.)

Baffle. 1. That which defeats or frustrates, hence in the flotation process, the projections or wings that divert or interrupt the flow of pulp in a vessel. (Rickard)
2. (Mid.) To brush out or mix fire damp with air. (Gresley)
3. *See* Baffle plate.

Baffle plate. A metal plate used to direct the flames and gas of a furnace to different parts so that all portions of it will be heated; a deflector. (Century)

Baffler. 1. (No. Staff.) The lever by which the throttle-valve of a winding engine is worked. (Gresley)
2. A partition in a furnace so placed as to aid the convection of heat; a baffle plate. (Century)

Baf week (No. of Eng.). The week next after the pay week, when wages are paid fortnightly. (Gresley)

Bag. 1. A paper container 1 to 2 inches in diameter and 8 to 18 inches long, used for placing an inert material such as sand, clay, etc., into a bore hole for stemming or tamping. Also called a Tamping bag. (Du Pont)
2. (So. Staff.) A quantity of fire damp suddenly given off by the coal seam. (Gresley)
3. A cavity in a mine containing gas or water. (Standard)
4. (or Baggit) (Scot.). To swell or bulge. (Barrowman)

Bagazo (Mex.). Waste from hand-jigging. Mud from drill hole. (Dwight)

Bag coal (Eng.). Coal put into coarse canvas bags and sold in small quantities. (Gresley)

Bag house. A large room or chamber, or series of rooms at metallurgical blast-furnace plants in which 3,000 to 4,500 bags are suspended for filtering furnace gases. Also used for the recovery of oxides, as arsenic, zinc, etc.

Bag of foulness (No. of Eng.). A cavity in a coal seam filled with fire damp under a high pressure, which, when cut into, is given off with much force. *See also* Bag, 2. (Gresley)

Bag of gas (Eng.). A gas-filled cavity found in seams of coal. *See also* Bag, 2. (G. C. Greenwell)

Bag process. A method of recovering fluedust and also sublimed lead whereby furnace gases and fumes are passed through bags suspended in a bag-house. The furnace gases are thus filtered and the particles in suspension collected. (Hofman, p. 131)

Bag room. A dust chamber in which bags are suspended for filtering the furnace gases in the bag process. *See also* Bag house.

Bagshot sands (Eng.). A series of Lower. Tertiary beds consisting chiefly of siliceous sand, and occupying extensive tracts round Bagshot in Surrey, and in the New Forest, Hampshire. (Page)

Bahar (Malay). A unit of weight equal to 4 cwt. (Lock)

Baikerinite. A thick tar-like fluid at 15°C., which constitutes 32.61 per cent of baikerite. (Bacon)

Baikerite. A wax-like mineral from the vicinity of Lake Baikal; it is apparently about 60 per cent ozocerite. (Bacon)

Bail. 1. To dip or throw out; as, to bail water. 2. To clear of water by dipping or throwing it out; as to bail a boat. (Standard)
3. The handle of a bucket used for hoisting ore, rock, water, etc., from a mine.

Bailer. 1. A long cylindrical sheet-iron vessel fitted with a valve at its lower extremity, used for raising the oil from the bottom of the well to the surface. *See also* American pump. (Mitzakis)
2. A person who removes water from a mine by dipping it up with a bucket. (Steel)
3. A metal tank, or skip, with a valve in the bottom, used for unwatering a mine.

Bailer shop. A term used in all Russian oil fields, for a shop in which bailers are made and kept in repair for use at oil wells. (Mitzakis)

Bailiff (Eng.). A name formerly used for manager of a mine. (Gresley)

Bailing. 1. One of the most common ways by which the petroleum that has collected at the bottom of a well is brought to the surface. *See* Bailer, 1. (Mitzakis)
2. Unwatering a mine. *See* Bailer, 2 and 3.

Bailing drum. A light winding drum from 10 to 18 feet in circumference, fixed in the derrick, usually driven by belting from a motor, around which the bailer rope is coiled. (Mitzakis)

Bailing tub. A wooden tank about 6 feet in diameter by 6 feet in height placed on trestles over the mouth of an oil well, and into which the bailer is emptied. (Mitzakis)

Bain (Scot.). Old form of Ben, 1, *which see.* (Barrowman)

Bait (No. of Eng.). Food taken by a miner during his shift. (Gresley)

Bait-poke (No. of Eng.). A bag for carrying a miner's lunch. (Gresley)

Bait time (Eng.). Meal time underground. A term in use in Northumberland and Durham; in other districts "snap" or "whiff." (Redmayne)

Baixada (Braz.). Low country, as the valley of a river. (Halse)

Bajada (Sp.). A ladder-way. (Lucas)

Baja de metales (Peru.). Lowering of ores from mine to mill. (Dwight)

Bajo. 1. (Mex.). Foot-wall. *See* Respaldo. 2. (Colom.). Low-lying alluvial mines which have to be unwatered by artificial means; generally deposits in present river beds. (Halse)

Bake. To dry, harden, or vitrify by exposure to heat, as in a furnace or kiln; as, to bake pottery or bricks. (Standard)

Bakie (Scot.). A sled, slipe, sleigh or sledge. (Barrowman)

Bakuin. A Russian machine oil, prepared from Baku petroleum; it has high viscosity and great power of resisting cold. (Bacon)

Bal. A Cornish name for a mine; a cluster of mines. (Century)

Bala limestone. In Wales, a limestone belonging to the Cambrian system and equivalent to the Trenton in New York, or at least in part. (Emmons, 1860)

Balance. 1. (Eng.). The counterpoise or weight attached by cable to the drum of a winding engine to balance the weight of the cage and hoisting cable and thus assist the engine in lifting the load out of the shaft.
2. An instrument for weighing. *See* Assay balance. 3. To weigh; to counterbalance or counterpoise. To settle as an account. (Webster)
4. (Nova Scotia). *See* Balance pit.

Balance bob. A heavy lever ballasted at one end, and attached at the other to the pump rod, the weight of which it thus helps to carry. When the shaft is deep, and the pump rods are consequently very heavy, balance bobs are put in at intervals of 200 or 300 feet, thus relieving the strain on the rods themselves and on the engine (Raymond). *See also* Bob.

Balance box. A large box placed on end of a balance bob and filled with old iron, rock, etc., to counterbalance the weight of pump rods. (C. and M. M. P.)

Balance brow. (No. Staff.). A self-acting inclined plane down which the cars of coal are lowered and the empties elevated upon a carriage or platform (Gresley). Also called Balance plane; Back balance.

Balance car. 1. In quarrying, a car loaded with iron or stone and connected by means of a steel cable with a channeling machine operat-

ing on an inclined track. Its purpose is to counteract the force of gravity and thus enable the channeling machine to operate with equal ease up and down hill. (Bowles) 2. A small weighted truck mounted upon a short inclined track, and carrying a sheave around which the rope of an endless haulage system passes as it winds off the drum. (C. and M. M. P.)

Balanced shot. In coal mining, a shot for which the drill hole is parallel to the face of the coal that is to be broken by it. (Steel)

Balance gate. A gate hung in the middle on a horizontal or vertical axis, as a flood gate, to facilitate turning in a current.

Balance pit (Eng.). The pit or shaft in which a balance (counter weight) rises and falls. (Gresley)

Balance plane. An inclined plane up which empty cars are hoisted by the weight of descending loaded cars. Also called Balance brow.

Balance rope (Scot.). A rope hung under the cage in a shaft to counterbalance the winding rope. (Barrowman)

Balanza (Mex.). A balance; small scales. (Halse)

Balanzón (Mex.). Main beam or balance bob of a Cornish pumping engine. (Dwight)

Balas; Balas-ruby. A rose-red variety of spinel. Corruption of Badakhshan, a locality in Afghanistan, where it is found. (Power)

Bald. Without framing. Said of a mine timber which has a flat end. (Sanders, p. 142)

Balde (Chile). A kibble. (Halse)

Balistite. *See* Ballistite.

Balk. 1. (Eng.) A more or less sudden thinning out, for a certain distance, of a bed of coal; a nip or want. Also spelled Baulk (Century). Also failure of coal in a coal stratum. (Tennessee Copper Co. *v.* Gadley, 207 Federal, p. 297) 2. A timber for supporting the roof of a mine, or for carrying any heavy load. (Gresley)

Balk-ground foreman. A foreman whose duties are to inspect and to see that the coal is properly mined where there are balks in the mine (Tennessee Copper Co. *v.* Gadley, 207 Federal, p. 297). *See* Balk, 1.

Balkstone (Eng.). A provincial name given to an impure stratified limestone. (Humble)

Ball. A pasty mass of puddled iron; a loup. (Standard)

Balland (No. of Eng.). Pulverized lead ore after separation from the gangue (Century). Lead concentrates.

Ballast. Broken stone, gravel, sand, etc., used for keeping railroad ties in place. (C. and M. M. P.)

Ballast car. A car used for carrying ballast, which may be unloaded from the side or bottom. (Webster)

Ballast engine. A steam engine used in excavating and for digging and raising stones and gravel for ballast. (Webster)

Ballast hammer. A hammer with a long handle and two faces, used to break stone ballast. (Webster)

Ballasting. 1. The act of furnishing with ballast. 2. Material for ballast (Standard). *See also* Ballast.

Ballast-shovel. A spoon-pointed shovel having a thick body. (Standard)

Ball breaker. A steel or iron ball that is hoisted by a derrick and allowed to fall on blocks of waste stone for the purpose of breaking them. (Bowles)

Ball clay. A plastic white-burning clay used as a bond in chinaware (Ries). Called also Pipe clay.

Ball grinder. A pulverizer or disintegrator formed by balls of metal inclosed in a rotating cylinder. The material to be crushed is broken by the attrition of the rolling balls (Century).

Balling. The aggregation of iron, in the puddling or the bloomary process, into balls or loups. (Raymond)

Balling furnace. 1. A kind of reverberatory furnace used in alkali works. 2. A furnace in which piles or fagots of wrought iron are placed to be heated preparatory to rolling. (Century)

Balling head. An attachment at the end of a carding machine for receiving and balling the wool silver. (Webster)

Balling tool. A tool used in collecting into a mass the iron in a puddling furnace preparatory to taking it to the hammer or squeezer; a rabble. (Century)

Ball ironstone. 1. (So. Staff.) Strata containing large argillaceous nodules of ironstone. (Gresley)
2. Nodular iron ore. (Webster)

Ballistite; Balistite. A smokeless powder consisting essentially of soluble cellulose nitrates and nitroglycerin. It is dark colored and rubbery. (Webster)

Ball joint. A flexible pipe joint made in the shape of a ball or sphere. (Nat. Tube Co.)

Ball mill. A short tube mill (*which see*) of relatively large diameter in which grinding is done by steel balls instead of pebbles. The discharge is usually through a screen.

Ball mine. Same as Ball ironstone, 1. (Century)

Ball-Norton magnetic separator. An apparatus consisting of two revolving drums within each of which is a series of stationary electromagnets extending the working length of the drum, but corresponding only to a portion of the periphery. The ore is fed on the top of the first drum, and as the drum revolves, the magnetic particles adhere to it, while the nonmagnetic fall into a tailings bin below. The magnetic particles, beyond the magnets, are thrown off by centrifugal force against the second drum. This either rotates faster or has a weaker magnetic field than the first drum, so that those particles least strongly attracted by the first drum fall from the second, making a middling product. (Liddell)

Ballon (Fr.). 1. A form of geological upheaval resulting in mountains, and characterized by rounded domes. (Standard)
2. The metal prolong fixed to a zinc condenser.

Ball porphyry. A variety of quartz prophyry in which balls of felsite are developed. (Power)

Ball soda. Crude soda. (Century)

Ball stamp (Lake Sup.). A stamp for crushing rock, operated directly by steam power, the stem of the stamp being at the same time the piston rod of a steam cylinder. (Raymond)

Ballstone. (Eng.). 1. A concretionary mass of crystalline limestone occurring in the form of balls, varying greatly in size, in the Wenlock limestone. Called also Woolpack. (Standard)
2. (No. Staff.) An ancient term for ironstone. (Gresley)

Ball-tiff. *See* Tiff, 2.

Ball vein. A vein in which nodular iron ore occurs; also, the ore itself (Standard). *See also* Ball ironstone, 1.

Balmaiden (Corn.). A girl employed in the mines. (Standard)

Balnstone (No. of Eng.). Stone or rock forming the roof. (Gresley)

Balsa (Mex.). 1. A movable platform suspended from a cable, used in timbering shafts. 2. A pool of stagnant water in a mine. (Dwight)

Baltimorite. A grayish-green, silky, fibrous, splintery serpentine: possibly an altered asbestos. (Standard)

Bamboo. In ceramics, cane-colored porcelain biscuit (unglazed porcelain) used in making domestic utensils. (Standard)

Bamboo ware. In ceramics, a yellow variety of Wedgwood ware named from its color. (Standard)

Banakite. A general name given by Iddings to a group of igneous rocks in the eastern portion of the Yellowstone Park, and chiefly in dikes. They are porphyritic and richly feldspathic. The phenocrysts are labradorite and the groundmass consists of alkali-feldspars. A little biotite and subordinate augite may be present. The group should be considered in connection with absarokite and shoshonite. (Kemp)

Banatite. A name coined by B. v. Cotta in 1865 to describe the dioritic rocks that are connected with a series of ore deposits in the Austrian province of the Banat. Accurate microscopical study has shown them to be of such varying mineralogy that the name has now slight definite significance. The rocks are largely quartz-diorites. (Kemp)

Banco (Sp.). 1. A carpenter's bench. 2. A solid bed of mineral having two faces exposed. 3. *B. de piedra*, any one bed or stratum of stone in a quarry. 4. *B. de tierra*, a ground sill, a mud sill. 5. (Mex.) Hard rock which narrows a vein, or makes it change its course. A horse. (Halse)
6. (Mex.). The crucible of a blast-furnace. 7. *B. de herrar*, a horse shoeing shop. (Dwight)

Banco de avios (Sp.). A bank which advances funds for the working of mines. (Halse)

Band. 1. Slate or other rock interstratified with coal. Commonly called Middle band in Arkansas; also Dirt band, Sulphur band, or other band, as the case may be. (Steel)
2. (Corn.) A bed or seam of coal.
3. (So. Staff.) A winding rope or chain. (Gresley)

Banda (Mex.). 1. Bolt. (Dwight)
2. Bank of a river. (Halse)

Band brake. A hand or power-actuated brake of a hoisting engine, consisting of a broad steel band lined with blocks of wood or other material, and which operates against the surface of the winding drum.

Bandeada (Mex.). Banded structure of veins. (Dwight)

Banded structure. A term applied to veins having distinct layers or bands. This may be due to successive periods of deposition, or replacement of some earlier rock. (Farrell)

Banded vein. A vein made up of layers of different minerals parallel with the walls (Power). Also called Ribbon vein.

Banderа (Mex.). A flag used in surveying to mark points. (Dwight)

Banderilla (Sp.). A paper cone kept in position by a piece of clay, used to mark the position of drill holes. (Halse)

Bandful (So. Staff.). A cage or, strictly speaking, a rope load; *e. g.*, a bandful of men (Gresley). *Compare* Bant.

Bandsman (Eng.). 1. A miner who operates the hoisting rope or band (Webster). A hoistman.
2. A loader or filler of coal, etc., underground. (Gresley)

Bandstone (White Cliff, N. S. W.). Flat bands of a usually harder nature than the adjoining strata, containing more or less opal, but found either just above or below the workable seams of opal. (Power)

Band wheel. The belt wheel on the axis of the drum which drives the walking beam of a well drill. (Mitzakis)

Bangerts. (Eng.). A coarse stopping for holding earth in place. (Hunt)

Banging-pieces (Eng.). *See* Catches, 1.

Banjo (Scot.). An iron frame for carrying a false clack, or valve. (Barrowman)

Bank. 1. (Derb.) The face of the coal at which miners are working.
2. An ore deposit or coal bed worked by surface excavations or drifts above water-level. (Raymond)
3. In English districts the area immediately surrounding the mouth of a shaft; the landing at the top. (Chance)
4. (Cumb.) A large heap or stack of mineral on the surface of the ground. 5. To manipulate coal, etc., on the bank. (Gresley)

Bank boss. Inside foreman of a mine; a mine boss; a mine captain. (Roy)

Bank claim. A mining claim on the bank of a stream. (Skinner)

Bank-engine (Eng.). An engine at the mouth of a mine shaft. (Standard)

Banker-off (Aust.). The man who attends to taking skips off the cage. (Power)

Banket (Trans.). 1. A conglomerate containing sufficient gold, or any other valuable metal, to be exploited as an ore deposit.
2. (Eng.) A stone-masons' or bricklayers' bench, on which to trim stone or brick. (Standard)

Bank head. The nearly level upper end of an inclined plane, next to the engine or drum. (C. and M. M. P.)

Bank-head machinery (Eng.). The hoisting, dumping and screening equipment at a coal-mining shaft. (Gresley)

Bank hook (Mid.). An iron hook with which the banksman pulls the full cars off the cage. (Gresley)

Banking. 1. (Mid.) Sorting and loading coal at the bank. 2. (Cumb.) Heaping up minerals on the surface for future sale. (Gresley)

Bank-level (York.). The level heading from which the bank is worked (Century). *See also* Bank, 1.

Bank of ovens. A row of ovens for converting coal into coke. (Power)

Bank-out (No. of Eng.). To store coal at the surface when short of wagons, or cars. (Gresley)

Bank plates (Eng.). Cast-iron sheets with which a landing is floored for the more expeditious manipulation of cars (Gresley). A turn-sheet.

Bank right (Aust.). The right to divert water to a bank claim. (Davies)

Bankman. 1. (Eng.). The man in attendance at the mouth of a shaft who superintends the work of sorting and loading the coal (Gresley). Sometimes called Lander.
2. (Aust.). *See* Banker-off.

Bankswoman (Eng.). A woman employed at the mine, to pick rock from, and clean the coal for the market. (Gresley)

Bank to Bank. A shift. The period included between the time a miner arrives at the working face and the time he leaves it.

Bank-work (York.). A system of working coal in South Yorkshire. (Gresley)

Bannock. 1. (So. Staff.) To hole on the top of a seam. 2. (Shrop.). Brownish-gray clay suitable for making into fire brick. (Gresley)

Baño (Mex.). Excess of mercury added to the *torta* to collect amalgam. (Dwight)

Baños (Mex.). Water collected in old mine workings. (Halse)

Banque (Sp.). Underhand stoping. (Halse)

Banquear (Colom.). To level ground; to grade for building purposes, or for depositing ore. (Halse)

Banqueo (Colom.). Ground leveled for building purposes, or for depositing ore. (Halse)

Banqueria (Bol.). In alluvial mining, a thick bed of blocks of granite, schists, and quartz. (Halse)

Banquillos (Sp.). Stools on which the *marquetas* are placed. (Min. Jour.)

Bant (Derb.). A certain number of men, usually three or four, who, prior to the introduction of cages, used to ride up and down a shaft sitting in short loose pieces of chain attached to a hemp rope, with their knees pointing inward toward the center of the shaft. There were usually two bants, the lower or bottom bant which was composed of men, and the upper or foaley bant which was made up of lads a few feet above the heads of the men (Gresley). *Compare* Bont, 1; *also* Tacklers.

Bar. 1. A drilling or tamping rod. 2. a vein or dike crossing a lode. (Hanks)
3. A bank of sand, gravel, or other material, especially at the mouth of a river or harbor. 4. A placer deposit, generally submerged, in the slack portion of a stream (Webster). Accumulations of gravel along the banks of a stream, and, which, when worked by the miners for gold, are called Bar diggings (Hanks)
5. A length of timber placed horizontally for supporting the roof. (Gresley). Synonym for Cap-piece in Australia. 6. *See* Sinker bar.

Baraboo. A Monadnock which has been buried by a series of strata and subsequently reexposed by the partial erosion of these younger strata. (Lahee, p. 322)

Barba (Mex.). Fire-bridge. (Dwight)

Barbados earth. A deposit consisting of fossil radiolarians. *See* Tripoli. (Chamberlin, vol. 1, p. 630)

Barbados tar. The dark green or black petroleum of Barbados, which was formerly widely used in medicine. (Bacon)

Barbotine. A thin clay paste used in low relief ornamentation of pottery. (Standard)

Bar diggings (Pac.). Gold-washing claims located on the bars (shallows) of a stream, and worked when the water is low, or otherwise, with the aid of cofferdams (Raymond). *See also* Bar, 4, and Diggings.

Bardiglio marble. An Italian stone obtained on Montalto, on the southern borders of Tuscany. (Merrill)

Bar drill. A drill similar to the tripod drill, but mounted on a bar supported by four legs. (Bowles)

Bare (Eng.). To strip or cut by the side of a fault, boundary, etc. (Gresley). To make bare.

Barequear (Colom.). In placer mining, to extract as much of the pay gravel as possible, without method, leaving the overburden untouched. (Halse)

Barequeo (Colom.). Extracting the rich ore by crude means. (Halse)

Barequero (Colom.). A placer miner who uses crude methods of alluvial washing (Halse). A spoiler. (Lucas)

Barfe Saturday (No. of Eng.). The Saturday upon which wages are not paid. (Gresley)

Barff's process. A method of protecting iron from rusting by oxidizing it with superheated steam. (Webster)

Bargain. Portion of mine worked by a gang on contract. (C. and M. M. P.)

Bargain-men (Newc.). Men who work by the bargain or contract. (Min. Jour.)

Bargain-work (No. of Eng.). Underground work done by contract, *e. g.* driving headings, road laying, etc. (Gresley)

Barges (Scot.). Sheets of iron, zinc, or wood, used in wet shafts or workings for diverting the water to one side. (Barrowman)

Barilla. An impure sodium carbonate and sulphate obtained by burning various species of land or marine plants; soda-ash. Used in making glass, soap, etc. (Standard)

Baring. 1. A making bare; an uncovering (Webster). *See* Stripping, 2.
2. The surface soil and useless strata overlying a seam of coal, clay, iron-stone, etc., which has to be removed preparatory to working the mineral. (Gresley)
3. The small coal made in undercutting a coal seam. (Webster)

Barite. Sulphate of barium, $BaSO_4$; also called Heavy-spar, from its high specific gravity. When finely ground it is used as an ingredient in certain paints, especially in place of white lead. Also called Barytes.

Bario (Mex.). Barium. (Dwight)

Baritina (Sp.). Heavy spar; barite (Lucas)

Barium. A chemical element belonging to the group of metals whose oxides are the alkaline earths. It is yellowish white, somewhat malleable, fusible at high temperature, burning easily when heated in air. Sp. gr. 3.6; atomic weight, 137.37; symbol, Ba. (Century). The commercial minerals are barite and witherite.

Barium sulphate. Barite, $BaSO_4$.

Barkevikite. A variety of amphibole close to arfvedsonite in composition. (Dana)

Barley; Barley coal. A steam size of anthracite known also as buckwheat No. 3, sized on a round punched plate. It passes through ¼-inch holes. At some mines it has to pass over $\frac{3}{32}$-inch holes and at others over $\frac{1}{16}$-inch holes. The American Society of Mechanical Engineers has recommended that with a screen with circular holes, barley shall pass through $\frac{3}{16}$-inch holes and pass over $\frac{3}{32}$-inch holes.

Barmaster (Derb.). A mining official who collects the dues or royalties, presides over the barmote, etc. (From Germ. *Bergmeister*). (Raymond)

Bar mining. The mining of river bars, usually between low and high waters, although the stream is sometimes deflected and the bar worked below water level (C. and M. M. P.). *See also* Bar diggings.

Barmote (Derb.). A hall or court in which trials relative to lead mines are held. (Min. Jour.)

Barney. A small car, or truck, attached to a rope and used to push cars up a slope or inclined plane (Raymond). Also called Bullfrog, Donkey, Ground hog, Larry, Ram, Mule, and Truck.

Barney-pit. A pit at the bottom of a slope or plane, into which the barney is lowered to allow the mine car to run over it to the foot of the plane. (Chance)

Barnhardtite. A massive orange-yellow copper and iron sulphide. (Standard)

Bar of ground (Eng.). An intersecting vein of different mineral substances (Bainbridge). A horse.

Barolite. Wadsworth's name for rocks composed of barite or celestite. (Kemp)

Barometer. An instrument for determining the weight or pressure of the atmosphere, and hence for judging of probable changes of weather, or for ascertaining the height of any ascent, etc. (Webster)

Barometer holiday (Derb.). Any day on which no work is carried on underground, owing to the very low state of the barometer (for instance, when it drops below say 29 inches), as much fire damp may be expected to be given off in the mine. (Gresley)

Barómetro (Mex.). Barometer. (Dwight)

Barquín (Sp.). A large bellows used in iron works. (Halse)

Barquina (Sp. Am.). A large furnace. (Halse)

Barra (Mex.). 1. Bar or ingot. 2. A share in a mine. (The ancient Spanish laws considered a mine as divided into 24 parts, each of which was called a *barra*.) *B. viudas* or *aviadas* are non-assessable shares,

which participate in the profits, but not in the expenses of mining. 3. *B. azucla*, a bar with a chisel bit. 4. *B. de plata*, silver in bars. 5. *B. pica*, or *B. de punta*, a bar with a diamond-shaped point. 6. *B. de uña*, a claw bar for drawing spikes. (Dwight)

Barracks shale. One of the principal oil-shale seams of Scotland. (Bacon)

Barradura (Sp. Am.). Raking into the sluice; scraping. (Lucas)

Barranca (Sp.). A ravine; a washout made by a heavy fall of rain. (Hanks)

Barrandite. A bluish, reddish, greenish, or yellowish-gray hydrous ferric aluminum phosphate, $(Al\ Fe)PO_4+2H_2O$, found in spheroidal concentration. (Standard)

Barrel. 1. The water-cylinder of a pump. 2. A piece of small pipe inserted in the end of a cartridge to carry the squib to the powder. 3. A vessel used in amalgamation. (Raymond)
4. The body of a windlass or a capstan about which the cable winds. (Webster)

Barrel amalgamation. *See* Barrel process.

Barrel chlorination. *See* Barrel process.

Barrel copper. Native copper occurring in small masses, separated easily from the matrix and shipped in barrels to the smelter (Webster). *See also* Barrel work; Barrilla, 1 and 2.

Barrel process. A process of extracting gold or silver by treating the ore in a revolving barrel, or drum, with mercury, chlorine, cyanide solution or other reagent. (Webster)

Barrel quartz. A term applied to certain corrugated veinlets of gold-bearing quartz found in Nova Scotia. (Ore Dep., p. 399)

Barrel-work (Lake Sup.). Native copper occurring in pieces of a size to be sorted out by hand in sufficient purity for smelting without mechanical concentration (Raymond). Also called Barrel copper.

Barren. Not containing mineral of value (Duryee). Not productive.

Barrena (Mex.). A hand drill for blasting. *B. viva*, a sharp drill; *B. muerta*, a dull drill. (Dwight)

Barrenar (Mex.). To drill; to fire a round of holes. (Dwight)

Barrenarse (Mex.). To connect with each other (as two mines or workings). (Dwight)

Barren contact. A contact vein, or a place in the contact vein, which has no mineral. (Crofutt)

Barrenero (Sp.). 1. A driller. 2. A boy who attends the boring tools. (Halse)

Barren ground. Strata containing seams of coal that are not of a workable thickness. In metal mining, ground that does not contain ore.

Barren measures. Coal measures without workable seams. (Standard)

Barreno (Mex.). 1. A drill hole. 2. A communication between two mine workings. 3. *B. en agua*, a downward hole. 4. *B. en seco*, an upward hole. (Dwight)
5. *B. á techo*, a drill hole in the roof. 6. *B. tenido*, a drill hole in the floor. 7. *B. de viento*, a jumper or churn drill. (Halse)

Barren solution. A working cyanide solution that contains little or no precious metal. The term refers to solution after precipitation of gold or silver, as distinct from pregnant solution.

Barrer (Sp.). To sweep. *B. por peña* (Colom.). To rake the gold-bearing gravel from bed rock with hoes. *B. un hoyo*, a similar operation applied to more limited areas. *B. el canalón*, an analogous operation in a ground sluice. *B. por planes*, to work in the upper part of the gold-bearing gravel, when it is not possible to clean up the bed rock. (Halse)

Barreta. 1. (Mex.). A crowbar. 2. *B. perdida* (Peru). Dead work in unprofitable prospecting. (Dwight)

Barretero. 1. (Sp.). A borer; a driller. 2. (Peru). A miner who works with pick, crowbar, and wedges. (Halse)
3. (Mex.). A first-class miner, able to locate, direct, drill, and blast holes. (Dwight)

Barricade. An artificial mound of earth, usually as high as the eaves of a magazine roof, erected to deflect the force of an explosion upward and to protect the inclosed building from flying objects. (Du Pont)

Barrier. 1. A solid block or rib of coal, left unworked between two collieries or mines for security against accidents (Gresley). *See also* Barrier pillar.
2. A low ridge built by wave action near shore. (Chamberlin)

Barrier pillar. A large pillar of coal left at intervals to localize the damage resulting from a crush or squeeze, inrush of water, or a mine explosion.

Barrier system (No. of Eng.). An approved method of working a colliery by pillar and stall, where solid ribs or barriers of coal are left in between working places. (Gresley)

Barril (Sp.). 1. A cask or barrel. 2. *B. de amalgamación*, amalgamation barrel. (Halse)

Barrilla (Bol.). 1. Native copper disseminated in copper ore. 2. Copper-ore concentrate. 3. Tin-ore concentrate containing 60 to 70 per cent metallic tin. 4. (Colom.) In gold mining, wooden divisions in blanket strakes, copper plates, etc. (Halse)

Barring. 1. (Eng.). The timbers in the workings for keeping up the roof. 2. (Scot.). The timber walling or casing of shafts. 3. (York). Using an iron bar to remove loose rocks after blasting. (Gresley)

Barring-down. 1. Removing loose rocks in the roof of a mine by means of a bar. 2. Loosening ore in a bin by means of a bar, so it will flow through the chute.

Barring scrap. Prying adhering scrap metal from runners, ladles, or skimmers. (Willcox)

Barrio (Mex.). A settlement. (Lucas)

Barro (Sp.). 1. Clay, loam, mud, earth. 2. *B. de olleros*, potters' clay. 3. Argillaceous marl. 4. (Colom.) Overburden of auriferous alluvial deposits. 5. (Braz.) A layer of fine sand mixed with clay. (Halse)

Barrow. 1. A vehicle in which ore, coal, etc., is wheeled. 2. (Corn.) A heap of attle or rubbish; a dump. (Raymond) 3. A wicker basket in which salt is put to drain. 4. (Eng.) A mountain or hill. (Webster)

Barrow man (Eng.). One who conveys coal underground in a wheelbarrow from the working places to the haulage ways (Gresley). Also called Putter.

Barrow tram. A shaft or handle of a wheelbarrow. (Webster)

Bars (Eng.). Strong timbers placed horizontally for supporting boards by which the faces of the excavation for a tunnel are supported. The "crown-bars" support the upper part of the excavation; the "side bars" the lateral portions. (Simms)

Barrow-way (Newc.). A level through which coal or ore is wheeled. (Raymond)

Bar screen. A device for separating different sizes of coal. It consists of a number of parallel inclined bars at regular distances apart along which the coal slides by gravity. *See also* Grizzly. (Steel)

Bar-timbering. A system of supporting a tunnel roof by long top bars while the entire lower tunnel-core is taken out, leaving an open space for the masons to run up the arching. Under certain conditions the bars are withdrawn after the masonry is completed, otherwise they are bricked in and not drawn. (Ihlseng)

Bartlett table. A three-shelf table driven by an eccentric that gives it a vanning motion. Ore and water are fed on the upper shelf giving two products, heads and tailings. The latter are retreated on the second shelf, and the tailings go to the third or lower shelf for retreatment.

Bartolina (Mex.). A watchman's house at the mine-entrance. (Dwight)

Barybiotite. A variety of biotite containing barium oxide. (Standard)

Barysphere. The central or deep interior portions of the earth, presumably composed of heavy metals or minerals. It is contrasted with Lithosphere, the outer stony shell (Kemp). Also called Pyrosphere.

Baryta. Barium oxide.

Baryta green. A pigment, essentially barium manganate. (Webster)

Baryta white. A pigment made of barite, $BaSO_4$.

Barytes. *See* Barite.

Baryto. A combining form denoting the presence of barium, as in *baryto*calcite, and *baryto*celestite. (Standard)

Barytocalcite. A carbonate of barium and calcium, $BaCO_3.CaCO_3$. (Dana)

Basal cleavage. Same as pinacoidal; cleavage parallel to the basal pinacoid, *i. e.*, perpendicular to the direction of elongation. (Butler)

Basal conglomerate. A conglomerate or coarse sandstone forming the lowest member of a series of related strata which lie unconformably on older rocks. It records the progressive encroachment of the seabeach on the former dry land. (Standard)

Basal plane. A plane parallel to the lateral or horizontal axes of a crystal. (Webster)

Basalt. A word of ancient but uncertain etymology. It is employed as a rock name in its restricted sense for porphyritic and felsitic rocks consisting of augite, olivine and plagioclase with varying amounts of a glassy base which may entirely disappear. In a broader sense the basalt or basaltic group is used to include all the dark, basic, volcanic rocks, such as the true basalts; the nepheline-, leucite-, and melilite-basalts; the augitites and limburgites; the diabases, and melaphyres. (Kemp)

Basalt glass. A black glassy form of basalt. (Webster)

Basaltic. Pertaining to, formed of, or containing basalt; as basaltic lava. (Webster)

Basaltic hornblende. A variety of hornblende found in volcanic rocks. (A. F. Rogers)

Basaltiform. In the form of basalt; columnar. (Webster)

Basaltine. 1. Same as Basaltic. 2. Same as Augite. (Standard)

Basalting. 1. A pavement made of blast furnace slag. 2. The process or operation of covering, as a road, with slag. (Standard)

Basalto (Sp.). Basalt. (Min. Jour.)

Basalt ware. In ceramics, a variety of wedgwood ware with a black body. (Standard)

Basanite. A very old term, first used as a synonym for Basalt; also formerly applied to the black, finely crystalline quartzite, used by old-time workers in the precious metals as a touchstone or test-stone by which to distinguish gold from brass by the streak. This variety was often called Lydian stone or Lydite. Basanite is now universally empolyed for those volcanic rocks that possess a porphyritic of felsitic texture and that contain plagioclase, augite, olivine and nepheline or leucite, one or both, each variety being distinguished by the prefix of one or the other, or of both of the last named minerals. (Kemp)

Basanitoid. A term suggested by Bücking for basaltic rocks, without definite nepheline, but with a glassy base. (Kemp)

Báscula (Mex.). A scale for weighing ore charges. (Dwight)

Base. 1. A compound capable of reacting with acids to form salts. 2. The basal plane of a crystal. 3. The ground mass of a fused magma, especially if glassy or not visibly crystalline. *See also* Basis. 4. A line in a survey which, being accurately determined, in length and position serves as the origin for computing the distances and relative positions of remote points and objects by triangulation. 5. The point or line from which a start is made in any action or operation; as, a price used as a unit from which to calculate other prices is often called Base price. 6. Of little comparative value, as metals inferior to silver and gold, which are precious metals. Alloyed with an inferior metal. (Webster)
7. The artificial foundation of a pavement. (Bacon)

Base bullion. The commercial name for argentiferous lead, as distinguished from silver or gold bullion. *Compare* Bullion, 1. (Hofman, p. 347)

Base course. The first or lowest course of a wall, as of a foundation. Also called Foundation course. (Webster)

Base goods. A term generally used to denote a material made by treating phosphate rock and some nitrogenous substance with sulphuric acid. Hair, leather, scrap fur, wool waste, feathers, shoddy, etc., are the nitrogenous materials most often used. Base is made with the same machinery that is used for making acid phosphate, and methods of operation are about the same. (Amer. Fert. Hand Book, 1917, p. 41)

Base level. 1. The level below which a land surface can not be reduced by running water. (Webster)
2. To reduce by erosion to or toward a base level. (Standard)

Base line. A line taken as the foundation of operations in trigonometrical and geological surveys (Emmons). *See also* Base, 4.

Basement complex. A series of rocks of great obscurity and complexity beneath the dominantly sedimentary rocks. They are at the bottom of the known series, but since they are not the true base or foundation, they are properly termed the Archean complex (Chamberlin). The rocks of the Archean system.

Base metal. Any metal as iron, lead, etc., which is altered by exposure to the air, etc., in contrast with the noble or precious metals. (Webster)

Baseness. 1. Liability to rust. 2. Inferiority due to alloy. (Standard)

Bash (So. Wales). To fill with rubbish the spaces from which the coal has been mined. (Gresley)

Basic. 1. In chemistry, performing the office of a base in a salt; having the base in excess. 2. Having more than one equivalent of the base for each equivalent of acid. (Century)
2. In geology, a general descriptive term for those igneous rocks that are comparatively low in silica. About 55 or 50 per cent is the superior limit. *Compare* Acidic. (Kemp)
3. In furnace practice, a slag in which the earthy bases are in excess of the amount required to form a neutral slag with the silica present. (Raymond)

Basic lining. A lining for furnaces, converters, etc., formed of nonsiliceous material, usually limestone, dolomite, lime, magnesia, or iron oxide. (Raymond)

Basic-lining process. An improvement of the Bessemer process, in which, by the use of a basic lining in the converter and by the addition of basic materials during the blow, it is possible to eliminate phosphorus from the pig iron, and keep it out of the steel. (Raymond)

Basic price. As applied to the price of metals, it is that figure at which the price is a minimum. *See* Normal price. (H. C. Hoover, p. 36)

Basic process. *See* Basic-lining process.

Basic rock. A term rather loosely used in lithology, generally to mean one of the following: (*a*) An igneous rock containing less than 55 per cent of silica, free or combined. (*b*) An igneous rock in which minerals comparatively low in silica and rich in the metallic bases, such as the amphiboles, the pyroxenes, biotite, and olivine, are dominant. (*c*) Very loosely, an igneous rock composed dominantly of dark-colored minerals. In all three senses contrasted with acid.
The term is misleading and undesirable and is going out of use. As used in the first sense above it is being replaced by *subsilicic* and as used in the second sense it should be replaced by *mafic* or by some term denoting the dominant mineral or minerals. (La Forge) *See* Basic, 2.

Basic salt. A salt in which the acid part of the compound is not sufficient to satisfy all the bonds of the base. (Dana)

Basic slag. The slag produced in steel making in the Thomas furnace, in which a basic calcareous or magnesian lining is used in the converter, and lime, either alone or with oxide of iron, is added to the charge of metal. Phosphorus is retained in the slag and carried off. (Standard)

Basic steel. Steel made by the basic process. (Standard)

Basin. 1. A large or small depression in the surface of the land, the lowest part of which may be occupied by a lake or pond. 2. An area or tract having certain common features throughout, particularly a tract where the strata dip from all sides toward a center. (Webster)
3. A natural depression of strata containing a coal bed or other stratified deposit. 4. The deposit itself. (Raymond)

Basining. In geology, a settlement of the ground in the form of basins, in many cases, at least, due to the solution and transportation of underground deposits of salt and gypsum. Such basining produces numerous depressions, from those of a few square yards to those 50 square miles in area, in the high-plains region east of the Rocky Mountains. (Standard)

Basis; Base. A term employed to describe that part of a fused rock magma that in cooling fails to crystallize as recognizable minerals, but chills as a glass, or related amorphous aggregate. It differs thus from groundmass, which is the relatively

fine portion of a porphyritic rock as distinguished from the phenocrysts. (Kemp)

Basker (Eng.). Old cloth use to cover wet holes to prevent splashing while drilling. (Bainbridge)

Basket (So. Staff.). 1. A shallow pan into which small coal is raked for loading into cars. 2. (Leic.) A measure of weight (2 cwt.) occasionally used in East Lancashire. (Gresley)
3. A group of several wooden stakes placed in the form of a small circle to mark and protect a point used in surveying.

Basonomelan. A variety of hematite containing titanium oxide. (Standard)

Basque. A lining for crucibles or furnaces; generally a mixture of clay, etc., with charcoal dust. (Raymond)

Bass; Batt. Same as Bind. *See also* Bat, 3.

Basset. (Derb.) 1. An outcrop; the edge of a stratum. (Raymond)
2. The shallow or rise side of a working. (Gresley)
3. To incline upward so as to appear at the surface; to crop out. (Webster)

Basset edge (Eng.). The actual outcrop of a seam or bed, where it appears at the surface. (Gresley)

Basseting. 1. Outcropping. 2. The cropping out or appearance of rock on the surface of a stratum, or series of strata. (Century)

Bastard. 1. Of unusual make or proportion; of abnormal shape. (Webster)
2. A hard massive bowlder or rock.

Bastard granite. A quarry term for gneissic granites. (Ries)

Bastard quartz. A miner's term for a white, glassy quartz without other mineralization.

Bastard whin (Eng.). Very hard rock, but not so flinty as to be called whin. (G. C. Greenwell)

Bastimento (Mex.). Miner's luncheon. (Dwight)

Bastite. Schiller spar. An altered enstatite or bronzite having approximately the composition of serpentine. (Dana)

Bastnäsite. A greasy, wax-yellow, fluocarbonate of cerium metals, crystallizing in the monoclinic system. (Dana)

Bastonite. A greenish-brown mica that is closely related to phlogopite. (Standard)

Basura de plomo (Mex.). Lead dross. (Dwight)

Bat. 1. A plate of gelatin used in printing on pottery or porcelain over the glaze. (Webster)
2. (Leic., So. Staff.) *See* Baffle, 2. Batting out gas was formerly a regular though unsafe thing to do. (Gresley, 1883)
3. (Eng.) A compact black bituminous shale which splits into fine laminae. Is often interstratified in layers with coal. Also spelled Batt, or Bass. (Redmayne)

Batán de piedra (Peru). A stone plate on which ore samples are ground. (Pfordte)

Batch. 1. A quantity of material destined for one operation. 2. A quantity of material produced at one operation. 3. The mixture of raw materials which by fusion is converted into glass. (Webster)
4. (Corn.) The quantity of ore sent to the surface by a pair of men (Raymond). Also called Batch of ore.

Bate. 1. (So. Staff.) To excavate or lower the floor of a mine (Gresley). *Compare* Brush, 8.

Batea (Mex.). A wide and shallow vessel, usually of wood, used for panning ore. (Dwight)

Bate barrel (Leic.). After drawing a number of barrels of water out of a sump, the first barrel for which there is not sufficient water to fill it. (Gresley)

Bateque (Lower Cal.). Deposits formed by spring water, as in a ravine or at the foot of a hill.

Bateria (Mex.). Battery. (Dwight)

Batework (Newc.). Short work. (Min. Jour.)

Bath. 1. A medium as sand, oil, water, or air for regulating the temperature of anything placed in or upon it; also the vessel containing such a medium. (Webster)
2. A mass of molten material in a furnace, or of solution in a tank. (Raymond)

Bath brick (Eng.). A fine calcareous and siliceous material used for polishing and cleansing metal objects: originally found near Bath, and usually pressed into brick. (Standard)

Bath metal. Any one of several varieties of brass. (Webster)

Batholite. *See* Batholith.

Batholith. A name suggested by Suess for the huge irregular masses of plutonic rocks that have crystallized in depth and that have only been exposed by erosion. The word is also spelled batholite, bathylite, and batholith. The last named is now generally preferred. (Kemp)

Batholithic. Pertaining to, originating in, or derived from a batholith. (Standard)

Bath oölite. A subgroup of the Low Oölite (Jurassic) of England (Standard). *See also* Bath stone.

Bath stone. A creamy limestone from the Bath oölite, soft and easily worked. It was used for building in England as early as the 12th century. (Standard)

Bathvillite. An amorphous, fawn-brown, opaque, very friable oxygenated hydrocarbon from Torbane Hill, Scotland; it is insoluble in benzol and is related to Torbane Hill mineral. *See also* Torbanite. (Bacon)

Bathylite. *See* Batholith.

Bathymetric. Relating to measurement of depths; usually applied to the ocean. (Sloan)

Batiboléo (Mex.). A company of miners working a stope of high-grade ore. (Dwight)

Batice. An inclination or bevel given to the upper timbers of a shaft; as the shaft has a downward and outward batice of 1 inch to the foot (Standard). *See also* Batter, 1.

Bating (Eng.). Lowering a drift or road (Bainbridge). *See also* Bate.

Batir (Colom.). 1. To break up and carry away auriferous gravels by water. 2. *B. el monte*, to explore the mountains. (Halse)

Bat-printing. The act or process of decorating glazed porcelain by means of a gelatin pad. The lines of the pattern are transferred in linseed oil from an incised plate to the pad, and thence to the porcelain, and this oil impression is then dusted with metallic pigment, which is fixed by firing. (Standard)

Batt (Eng.). Shale; hardened clay, but not fire clay. Same as Bend and Bind (Chance). *See also* Bat, 3.

Battage (Fr.) The operation of pulverizing or incorporating the ingredients of gunpowder by the old method of stamping with pestles. (Century)

Batten. A strip of wood used for nailing across two other pieces to hold them together or for covering a crack. (Webster)

Batter. 1. The inclination of a face of masonry or of an inclined portion of a frame or metal structure. C. and M. M. P.) Also called Battice.
2. A paste of clay or loam. 3. A mallet for flattening wet clay on the batting block. (Webster)

Battered set. A set of mine timbers in which the posts are inclined. (Sanders, p. 164.)

Battery. 1. A set of stamps in a stamp mill. *See also* Machine, 4. 2. A bulkhead of timber. 3. The plank closing the bottom of a coal chute. (Raymond)
4. A platform on which the miners stand in thin steep-pitching beds of coal. (Chance)
5. *See* Blasting machine. 6. *See* Storage battery.

Battery-amalgamation. Amalgamation by means of mercury placed in the mortar of a stamp battery. (Raymond)

Battery assay. *See* Pulp assay.

Battery of holes. A number of charges, in drill holes, fired simultaneously with an electric current (Bowles). Also called Multiple shot.

Battery of ovens. *See* Bank of ovens.

Battery solution. A cyanide, or plain alkaline solution added to the ore when being crushed in a stamp mill. (Fulton, p. 34)

Batting block. In ceramics, a plaster slab on which plastic clay is beaten before going to the whirling table. (Standard)

Battu-uji (Malay). Touchstone. (Lock)

Batu Kawi (Sumatra). A red stone supposed to be an infallible sign of gold. (Lock)

Bauleao (Sp. Am.). Pyrite with cubic crystallization. (Lucas)

Baulite. *See* Krablite.

Baulk. *See* Balk, 1.

Baum-pots (York.). Calcareous nodules found in the shale forming the roof of the "Halifax hard" coal seam. (Gresley)

Bauxite. Hydrated alumina. Essentially $Al_2O_3.2H_2O$ (Dana). The principal ore of aluminum.

Baveno twin. A twin crystal of a kind shown by orthoclase, in which the twining plane is the clinodome, resulting in a nearly square form. (Webster)

Bavin (Eng.). Impure limestone. (Standard)

Bawke (Eng.). A bucket for raising coal (Standard). *See also* Bowk, 1 and 2.

Bay. 1. An open space for waste between two packs in a longwall working. *See also* Bord. (C. and M. M. P.)
2. An inlet of the sea usually smaller than a gulf, but of the same general character. (Webster)

Bayou. 1. A sluggish or stagnant inlet or outlet from a lake or bay, or one connecting two bodies of water. (Standard)
2. *See* Oxbow.

Bay salt. The large crystalline salt of commerce, especially that obtained from sea water by evaporation in shallow pits or basins by the heat of the sun. (Webster)

Bayshon (Som.). An air stopping. (Gresley)

Bazofia (Peru). Waste rock. (Dwight)

Beach. The washed shore of a sea or lake. (Hitchcock)

Beach combing. Working the sands on a beach for gold, tin, or platinum. (C. and M. M. P.)

Beach placers. Placer deposits either on a present or ancient sea beach. There are a series of these at Nome, Alaska, known there as first, second, or third beach, etc., due to change of shore line.

Bead. 1. The globule of precious metal obtained by the cupellation process. 2. A glassy drop of flux, as borax, used as a solvent for a color test for several mineral earths and oxides before the blowpipe. (Webster)

Bead furnace. A furnace in which small cylinders of glass are rounded into beads. The cylinders are heated to softening and revolved in a drum. (Webster)

Beam compass. An instrument consisting of a wooden or brass beam having sliding sockets that carry steel or pencil points, used for describing large circles and for laying off distances. (Century)

Bean ore. A name for limonite, when found in lenticular aggregations. Called also Pea ore, when found in small, rounded masses (Chester). A coarse-grained pisolitic iron ore. (Power)

Beans (No. of Eng.). All coal which will pass through a half-inch screen or mesh. (Gresley)

Bean-shot. Copper granulated by pouring into hot water. (Raymond)

Bear. 1. *See* Salamander; *also* Sow.
2. To bear in. Underholing or undermining; driving in at the top or at the side of a working. (Chance)

Bearer bar. One of the bars which support the gratebars in a furnace. (Century)

Bearers. 1. (So. Staff.) Women formerly employed to carry coal out of the mines. (Gresley)
2. Heavy timbers placed in a shaft at intervals of 30 to 100 ft. to support the shaft sets. They are usually put beneath the end plates and dividers, and rest in hitches cut in the wall. Also used to support pumping gear.

Bearers' way (Scot.). An underground road or passage along which the bearers carry coal. (Barrowman)

Bearing. 1. The course or direction indicated by a compass. 2. The strike or course of a vein. 3. The points of support of a beam, shaft, or axle. (Steel)

Bearing door. A door placed for the purpose of directing and regulating the amount of ventilation passing through a portion of the mine. (Gresley)

Bearing-in. The depth of an undercut, or holing, from the face of the coal to the end of the under-cut. (Steel)

Bearing pit (Scot.). A shaft up which coal was (in former years) carried by bearers. (Barrowman)

Bearing road (Scot.). *See* Bearer's way.

Bearing system (Eng.). The employment of women to carry coal out of the mine. (Gresley)

Bearing-up pulley. A pulley wheel fixed in a frame and arranged to tighten or take up the slack rope in endless haulage. (Gresley)

Bearing-up stop. A partition or brattice of plank that serves to conduct air to a face. (Ihlseng)

Bears (Derb.). Calcareous nodules of clay-ironstone. (Gresley)

Beat (Eng.). 1. The surface outcrop of a load or bed. (Davies)
2. (Corn.) To stope. (Pryce)

Beat away. A process of working hard ground by wedges and sledge hammers. (Skinner)

Beater. 1. (No. of Eng.) An iron rod for packing the stemming on a charge of powder in a drill hole. (Webster)
2. (Mid.) A wooden mallet for consolidating, or packing, the clay in building a wall or dam to make it air-tight. (Gresley)

Beat-hand (Eng.). A hand which, from being vesicated or blistered with hard work, has festered. (G. C. Greenwell)

Beaumontite. A variety of heulandite. (Dana)

Beauxite. *See* Bauxite.

Beaverite. A hydrous sulphate of copper, lead, and ferric iron $CuO.PbO.Fe_2O_3.2SO_3.4H_2O$. (U. S. Geol. Surv.)

Beche; Biche (Eng.). A deep conical instrument about 25 inches long, and weighing 6 pounds. The hollow part extends 16 inches up into the tool, and is 1½ inches in diameter at the lower end, and tapers to ⅝ inch at the upper end. It is used for extracting the bottom portion of a broken set of rods from a bore hole. (G. C. Greenwell)

Bechilite. An incrustation of hydrous calcium borate, $H_8CaB_4O_{11}$, found as a deposit at the boric acid lagoons of Tuscany. (Standard)

Becke test. In optical mineralogy, a test for relative indices of refraction. (A. F. Rogers)

Becquerel rays. Radiations from uranium compounds. (Webster)

Bed. 1. The smallest division of a stratified series, and marked by a more or less well defined divisional plane from its neighbors above and below. (Kemp)
2. A seam or deposit of mineral, later in origin than the rock below, and older than the rock above; that is to say, a regular member of the series of formations, and not an intrusion (Raymond). A deposit, as of ore (or coal), parallel to the stratification. (Standard)
3. That portion of an outcrop or face of a quarry which occurs between two bedding planes. (Buckley)
4. The level surface of rock upon which a curb or crib is laid. (Gresley)
5. The bottom of a water course, or of any body of water. 6. A mass or heap of anything (as ore), arranged in the form of a bed. (Webster)

Bed claim (Aust.). A mining claim lying on the bed of a stream. (Davies)

Bedded. Applied to rocks resulting from consolidated sediments, and accordingly exhibiting planes of separation designated bedding planes. (Sloan)

Bedded deposit. *See* Bedded formation.

Bedded formation. A formation which shows successive beds, layers, or strata, due to the manner in which it was formed (Farrell). A bedded deposit.

Bedded vein. Properly "bed vein" (*Lagergang* of the Germans); a lode occupying the position of a bed, that is, parallel with the stratification of the inclosing rocks. (Raymond) *See also* Bed, 2.

Bedded volcano. A volcano whose crater consists of layers of tuffs and lava sheets. (Century)

Bedding. 1. The exact equivalent of stratification, or occurrence in strata or beds (Century). *See also* Bed, 1 and 2.
2. The arrangement of coke, ore, flux, etc., in layers for storage or treatment.

Bedding fault. In geology, a dislocation which follows planes of stratification. (Standard)

Bedding planes. The planes or surfaces separating the individual laminæ or beds of a sedimentary rock. (La Forge) *See also* Stratification planes.

Bede. A miner's pickaxe. (Raymond)

Bedford limestone. A light-colored oölitic limestone from Bedford, Indiana (Webster). Much used as a building stone.

Bed joint. A horizontal joint (Webster). *See also* Bedding plane. Originally horizontal, but may be found inclined due to later uplifting.

Bedplate. 1. An iron plate forming the bottom for a furnace. 2. A heavy plate for supporting an engine or other heavy machinery. (Webster)

Bedrock. The solid rock underlying auriferous gravel, sand, clay, etc., and upon which the alluvial gold rests (Roy. Com.). Any solid rock underlying soil, sand, clay, etc.

Beds of passage. Beds in which the fossils or rocks, from their resemblance to those contained either in the bed above or the bed below, indicate the transition character of the deposit. (Standard)

Bedstone. In milling, the lower or stationary millstone. (Century)

Bed vein. *See* Bedded vein.

Bedway. An appearance of stratification, or parallel marking, in granite. (Raymond)

Beech coal. Charcoal made from beech wood. (Century)

Beeches (Scot.). Strips of hardwood fastened to pump rods to save them from wear at the collars. (Barrowman)

Beehive coke. Coke made in a beehive oven. (Webster)

Beehive oven. An oven for the manufacture of coke, shaped like the old-fashioned beehive (Raymond). The volatile products as tar, gas, and ammonia are not saved.

Beekite. A crytocrystalline variety of quartz, resembling chalcedony, formed by the replacement of limestone, as coral, or shells, with silica. (Standard)

Beele (Prov. Eng.). A mining pickax with both ends sharp. (Standard)

Beerbachite. A name given by Chelius to certain small dikes, asociated with and penetrating large, gabbro masses, and having themselves the composition and texture of gabbro. The name was coined in the attempt to carry out the questionable separation of the dike rocks from large, plutonic or volcanic masses of the same mineralogy and structure. (Kemp)

Beer stone (Eng.). An argillaceous and siliceous freestone dug from quarries at Beer, ten miles west of Lyme Regis, at the passing of the chalk into the greensand. (Roberts)

Beetle (Eng.). A small compressed-air locomotive employed on the haulage-ways at Newbottle Collieries. (G. C. Greenwell)

Beetle-stone. A nodule of coprolitic ironstone, so named from the resemblance of the inclosed coprolite to the body and limbs of a beetle. (Century)

Before breast. Rock or vein material, which still lies ahead. (C. and M. M. P.)

Behead. In geology, to cut off and capture by erosion the upper portion of a watercourse: said of the encroachment of a stronger stream upon a weaker one. (Standard)

Bekko ware. A yellow-brown splashed pottery made in Japan. It resembles tortoise shell. (Century)

Belgian oven. A rectangular oven with end doors and side flues for the manufacture of coke. (Raymond)

Belgian process. A process most commonly employed in the smelting of zinc. Roasted zince ore, mixed with a reducing material, as coal or coke, is placed in retorts which consist of cylindrical pipes of refractory material closed at one end, of a length and diameter convenient for charging and cleaning them. A number of these retorts are placed slightly inclined in a properly constructed furnace. The open ends of the retorts are covered with a sheet-iron hood to which are connected short conical sheet-iron pipes discharging the molten zinc downward. (Goesel)

Belgian zinc-furnace. A furnace in which zinc is reduced and distilled from calcined ores in tubular retorts (Raymond). These furnaces may be classified as direct-fired and gas-fired, but there is no sharp division between these systems, which merge into one another by difficulty definable gradations. Each class of furnace may be subdivided into recuperative and nonrecuperative, but heat recuperation in connection with direct firing is rare. (Ingalls, p. 428).

Bell. 1. Overhanging rock of bell-like form, not securely attached to the mine roof. "Pot" is the common Arkansas term. (Steel)
2. A gong used as a signal at mine shafts. 3. To signal by ringing a bell.

Belland. 1. (Eng.) Dusty lead ore. (Bainbridge)
2. A form of lead poisoning to which lead miners are subject. (C. and M. M. P.)

Bell-and-hopper. *See* Cup-and-cone.

Bell-and-spigot joint. The usual term for the joint in cast iron pipe. Each piece is made with an enlarged diameter or bell at one end into which the plain or spigot end of another piece is inserted when laying. The joint is then made tight by cement, oakum, lead, rubber, or other suitable substance which is driven in or calked into the bell and around the spigot. (Nat. Tube Co.)

Bell crank (Scot.). A triangular iron frame used to change the direction of reciprocating motion. (Barrowman)

Belled (Eng.) Widened. Said of the enlarged portion of a shaft at the landing for running the cars past the shaft, and for caging. (Gresley)

Belleek porcelain. An extremely thin ware, decorated with a nacreous luster suggesting the interior of shells, made originally in Belleek, Ireland, and since successfully imitated in Trenton, N. J., and elsewhere. (Standard)

Bell holes. 1. Holes dug or excavations made at the section joints of a pipe line for the purpose of repairs. (Moore *v.* Hole Natural Gas Co., 66 Southeastern, p. 565)
2. A conical cavity in a coal-mine roof caused by the falling of a large concretion; or, as of a bell-mold.

Bellies. Widenings in a vein (Power). *See also* Belly.

Bellite. An explosive consisting of five parts of ammonium nitrate to one of metadinitrobenzene, usually with some potassium nitrate. (Webster)

Bell metal. A hard bronze, containing sometimes small proportions of iron, zinc, or lead, but ordinarily consisting of 78 parts copper to 22 tin. (Raymond)

Bell-metal ore. (Corn.) An early name for tin pyrites, so called on account of its bronze color. (Chester)

Bell-mold; Bell-mould; Bellmouth (Som.). A conical shaped patch of a mine roof, probably originating with the fossils called *sigillaria*, or the roots of trees (Gresley). *See also* Bell, 1.

Bellows. An instrument or machine for blowing fires or for ventilating purposes. (Webster)

Bell-pit (Derb.). A mine working argillaceous ironstone by a system called Bell-work (Gresley). *See also* Bell-work.

Bell process. *See* Bell's dephosphorizing process.

Bells. Signals for lowering and hoisting the bucket, skip, or cage in a shaft. Usually given by bells, the number of strokes indicating the nature of the load, the place for stopping, etc. (Weed)

Bell screw; Screw bell. An internally threaded bell-shaped iron bar, for recovering broken or lost rods in a deep bore hole. *See also* Biche. (Gresley)

Bell's dephosphorizing process. The removal of phosphorus from molten pig iron in a puddling furnace, lined with iron oxide and fitted with a mechanical rabble to agitate the bath. Red-hot iron ore is added. *See also* Krupp's washing process. (Raymond)

Bell-sheave (Aust.). A sheave in the shape of a truncated cone, used in connection with the main-and-tail system of rope haulage at curves, so as to keep the rope close to the ground. (Power)

Bell-work. 1. (Derb.). A system of working an iron-stone measure by upward underground excavations, around the shafts (raises) in the form of a bell or cone (Gresley). *Compare* Milling.
2. A method also used in working salt deposits. (Standard)

Belly. A bulge, or mass of ore in a lode. (Skinner)

Belly-helve (Eng.). A forge hammer, lifted by a cam which acts about midway between the fulcrum and the head. (Raymond)

Belly-pipe. A flaring mouthed blast pipe in an iron furnace. (Standard)

Belonesite. A white transparent magnesium molybdate, $MgMoO_4$, crystallizing in the tetragonal system. (Dana)

Belonite. A rod-shaped or club-shaped microscopic embryonic crystal in a glassy rock. (Kemp)

Belt. 1. A zone or band of a particular kind of rock strata exposed on the surface (Roy. Com.). *Compare* Zone.
2. A continuous strap or band for transmitting power from one wheel to another, or (rarely) to a shaft, by friction. (Standard)

Belugite. A name based upon the Beluga River, Alaska, and suggested by J. E. Spurr for a transition group of plagioclase rocks between his diorites and diabases. Spurr restricts the name diorite to those plagioclase rocks (without regard to the dark silicate) whose plagioclase belongs in the andesine-oligoclase series. The diabase group, on the other hand, contains those whose plagioclase belongs in the labradorite-anorthite series. Belugites with a porphyritic texture and a fine-grained or aphanitic groundmass are called Aleutites. (Kemp)

Ben. 1. (Scot.). Inward; toward the workings; the workman's right to enter the pit. 2. The day's work of a youth, indicating the proportion of a man's task which he is able or allowed to put out, is termed quarter-ben, half-ben, three-quarter-ben. (Barrowman)
3. A mountain peak: a word occurring chiefly in the names of many of the highest summits of the mountains of Scotland, as Ben Nevis. (Century)

Bench. 1. One of two or more divisions of a coal seam, separated by slate, etc., or simply separated by the process of cutting the coal, one bench or layer being cut before the adjacent one. 2. To cut the coal in benches. (Raymond)
3. A terrace on the side of a river or lake, having at one time formed its bank. (Power) *See also* Benches.
4. A small tram or car of about 7 cubic feet capacity used for carrying coal from the face to the chute down which it is dumped to the gangway platform for reloading into larger cars. 5. (Leic.). To wedge the bottoms up below the holing. (Gresley)
6. A level layer worked separately in a mine. 7. A group of retorts in an oven or furnace; also the complete oven or furnace containing a set or group of retorts for generating illuminating gas. (Webster)
8. (Eng.). A ledge left, in tunnel construction work, on the edge of a cutting in earth or in rock. (Simms)
9. (Scot.). A landing place. (Barrowman)

Bench-and-bench (Ark.). That plan of mining coal in a room which requires the blasting of the two benches of coal alternately, each a little beyond the other (Steel). Also called Bench working.

Bench diggings. River placers not subject to overflows (C. and M. M. P.) *See also* Bench placers.

Benchers (Eng.). Men employed in the mine at the bottom of inclined planes. (Gresley)

Benches. A name applied to ledges of all kinds of rock that are shaped like steps or terraces. They may be developed either naturally in the ordinary processes of land degradation, faulting, and the like; or by artificial excavation in mines and quarries. (Kemp)

Bench gravel (Yukon and Alaska). Gravel beds which occur on the sides of the valleys above the present stream bottoms, representing parts of the bed of the stream when it was at a higher level. Regarded by Tyrell as the terminal moraines of small glaciers. (Ore Dep., p. 398)

Benching. 1. (Eng.) *See* holing. To break the bottom coal with wedges when the holing is done in the middle of the seam. 2. (Ches.) The lower portion of the rock-salt bed worked in one operation. (Gresley)
3. *See* Bench, 8. (Simms)
4. (Eng.). Benches collectively as in a mine (Webster). *See also* Bench, 6.

Benching shot (Scot.) A shot placed in a hole bored vertically downward in an open face of work. (Barrowman)

Benching-up (Newc.). Working on the top of coal. (Raymond)

Bench mark. A mark, the elevation of which is known or assumed and used as a reference point by a surveyor.

Bench placers. Placers in ancient stream deposits from 50 to 300 feet above present streams. (U. S. Geol. Surv., Bull. 259, p. 33)

Bench stone. A rectangular stone measuring from 4 to 8 or 9 inches long by approximately 2 inches wide and varying in thicknesses. In use it generally rests on the artisan's bench, whence its name. Some bench stones are made circular for those who prefer the rotary motion in sharpening chisels and similar instruments. (Pike)

Bench working. The system of working one or more seams or beds of mineral by open working or stripping, in stages or steps (C. and M. M. P.). Also called Bench-and-bench.

Benchy. Forming frequent benches: said of a lode. (Standard)

Bend (Corn.). Indurated clay; a term applied by the miner to any hardened argillaceous substance. *See* also Bind, 1. (Whitney)

Bend away; or, Away (No. of Eng.). An exclamation meaning to raise the cage in the shaft. (Gresley)

Bender (Eng.) An iron loop on pump cylinders for attaching a hoisting rope. (Bainbridge)

Bending stress. The stress produced in the outer fibers of a rope by bending over a sheave or drum. (C. M. P.)

Bends. *See* Caisson disease.

Bend up; Bend up a bit (Eng.) An order to raise the cage slowly, so that it may be instantly stopped on the order "Hold" being given. (G. C. Greenwell)

Beneficiación (Sp.). As used in English usually means the reduction of ores. (Raymond)

Beneficiar (Sp.). 1. To work or improve a mine. 2. To derive profit from working a mine. (Halse)
3. (Mex.) To treat ores for extraction of metallic contents; to *beneficiate*. (Dwight)

Beneficiate. 1. To work or improve, as a mine. 2. To reduce, as ores. (Standard)

Beneficiation. The reduction of ores. (Webster)

Beneficio (Sp.). 1. The working of mines. 2. Profit derived from working a mine. 3. Metallurgical processes. *B. de caso*, the caldron or hot amalgamation process. *B. de Merro*, amalgamation reduction with the addition of fragments of iron. *B. de colpa*, the *patio* process with *colpa* in lieu of *magistral*. *B. de pella de plata*, amalgamation reduction with the addition of silver amalgam. *B. de patio*, the *patio* or cold amalgamation process. *B. de toneles*, the Freiberg or barrel amalgamation process. *B. por cianuración*, the cyanide process. *B. por cloruración*, the chlorination process. *B. por fuego*, reduction by smelting. 4. *B. de metales*, mechanical preparation of ores; ore dressing. (Halse)

Ben-Heyl (Corn.). A stream, where tin ore is found. (Davies)

Benitoite. A blue barium-titanium silicate, $BaTiSi_3O_9$, so far found only in California. Used as a gem. (U. S. Geol. Surv.)

Benk (Eng.). The working face of a coal bed (Bainbridge). A variation of Bench.

Bent. 1. (Scot.). The subsidence of roof near working face, *e. g.* a bent roof. (Gresley)
2. A framed section placed together on the ground, and afterwards raised to a vertical position. (Webster)
3. (Derb.). An offshoot from a vein. (Hooson)

Bentonite. A bedded plastic clay which swells very greatly upon wetting. (U. S. Geol. Surv.)

Benzine. A colorless, inflammable and volatile liquid obtained from petroleum by fractional distillation and consisting of various hydrocarbons. Called also Petroleum spirit. (Standard)

Benzinum. A distillate from American petroleum consisting of hydrocarbons chiefly of the marsh-gas series. (Bacon)

Benzoline. 1. The more volatile portion obtained on redistilling benzine; boiling point about 70°–95° C. Often used as synonymous with Benzine. (Bacon)
2. A mixture containing hexane, heptane, octane, and other paraffins, petroleum spirit or legroin. (Standard)

Benzoyl. The commercial name applied to a mixture of substances, including benzene and its homologues. (Mitzakis)

Beraunite. A foliated and columnar red to reddish-brown hydrous ferric phosphate. (Dana)

Berdan pan. Essentially a revolving circular trough, set at an inclination of about 45 deg. carrying a large ball or drag, and used to amalgamate the gold or silver.

Berea sandstone. Berea grit. A rock formation consisting of fine-grained sandstone and grit, generally considered as the base of the Carboniferous system in Ohio. It is much used as a building stone and for grindstones, and is one of the principal oil-bearing formations of the State. (La Forge)

Berengelite. A dark brown, resinous, asphalt-like mineral, soluble in cold alcohol but nearly insoluble in potassium hydroxide. Found near Arica, Peru. (Bacon)

Beresite. A name coined by Rose for a muscovite-granite that forms dikes in the gold district of Beresovsk in the Urals. It is, therefore, practically a synonym for aplite, as earlier defined, but some of the beresites have since been shown to be practically without feldspar and to form a very exceptional aggregate of quartz and muscovite. (Kemp)

Bergmehl; Bergmeal. 1. An infusorial earth, sometimes eaten mixed with meal or bark. Called al: Mountain-meal. 2. A white efflorescence of calcite, resembling cotton. Called also Rock-meal and Fossil-farina. (Standard)

Bergmeister (Pr.) An inspector of mines. (Gresley)

Bergschrund (Ger.). In geology, a rifting and faulting in a solid mass of rock or glacial ice. (Standard)

Berg-till. *See* Till.

Berilo (Sp.). Beryl; *B. verdemar*, aquamarine. (Halse)

Berlin blue. In optical mineralogy, an anomalous interference color of the first order. (A. F. Rogers)

Berlin iron. A soft iron, containing phosphorous, making very fine smooth castings, and used for ornaments and jewelry. (Standard)

Bermellón (Sp.). Vermilion; an earthy variety of cinnabar. (Halse)

Bernardo's process. A method for the electric welding of iron. (Goesel)

Berthierite. A sulphide of antimony and iron, of a dark steel-gray color, $FeS.Sb_2S_3$. (Dana)

Bertrandite. A brilliant, transparent, colorless, hydrous glucinum silicate, $H_2Gl_4Si_2O_9$, crystallizing in the orthorhombic system. (Standard)

Bertrand lens. In optical mineralogy, a small lens inserted in the microscope tube to magnify the interference figure. (A. F. Rogers)

Beryl. A glucinum-aluminum silicate, $3GlO.Al_2O_3.6SiO_2$. Used as a gem when clear and well colored. The grass-green variety is known as emerald; light-green, beryl; blue-green, aquamarine. Contains 14 per cent glucina (glucinum oxide). (U. S. Geol. Surv.)

Beryllium. *See* Glucinum.

Berylloid. In crystallography, a solid included under twenty-four similar scalene triangular faces. (Standard)

Berzelianite. A copper selenide, Cu_2Se, having a silver white color when freshly broken. (Webster)

Berzeliite. A massive bright, yellow, brittle calcium-magnesium-manganese arsenate, $(Ca,Mg,Mn)_3As_2O_8$. (Dana)

Bessemer. A product of the Bessemer process, as Bessemer steel: named from Henry Bessemer, who patented the process in 1855: used also attributively; as, Bessemer converter, flame or process. (Standard)

Bessemer iron. Pig iron suitable for the Bessemer process. (Raymond)

Bessemer ore. Iron ore containing little or no phosphorus hence especially suited for use in the Bessemer process. (Standard)

Bessemer process. The process of decarburizing a bath of molten cast iron by blowing air through it, in a vessel called a converter (Raymond). Other impurities, in small amounts, are also eliminated. Also, by analogy, the enrichment of copper matte by blowing air through it when molten, thus oxidizing the sulphur which escapes as SO_2. The iron combines with silica, forming a slag. *See also* Converting.

Bessemer steel. Steel made by the Bessemer process. (C. and M. M. P.)

Beta-jaulingite. A brownish yellow resin, obtained from the residue of Jaulingite, by the action of ethyl ether, after treatment with carbon disulphide. (Bacon)

Bethell process. A process of timber preservation in which a heavy coal-tar oil is used. *See also* Gallatin.

Beting (Malay) A quartzose-gold matrix. (Lock)

Béton (Fr.). Concrete made after the French fashion by mixing gravel or other material with a mortar of cement and sand. (Webster)

Betriebsfuhrer (Pr.). The mining engineer or manager of a coal mine, who is personally responsible for the safety of the workings. (Gresley)

Betriebsplan (Pr.). A sketch or rough plan of underground workings, to be developed during the next 12 months. (Gresley)

Betrunked. Deprived of its trunk or main body; said of certain river systems, whose tributaries in the dry season, for lack of sufficient water, fail to unite in a main trunk, but are dissipated in the arid ground. (Standard)

Betterness. Fineness of gold and silver above the standard. (Standard)

Betts lead-refining process. An electrolytic process using $PbSiF_6$ acidulated with hydrofluoric acid as the electrolyte. (Liddell)

Betún (Sp.) Bitumen; asphaltum. *B. marga*, bituminous marl. (Halse)

Beudantite. A ferric lead sulphate or arsenate occurring in green to black rhombohedral crystals. (Shaller, Wash. Ac. Sci., vol. 1, p. 112; 1911)

Beuheyl (Corn.) A live stream (vein), that is, one rich in tin (Pryce). Also spelled Ben-Heyl.

Bevel. 1. The angle which one surface or line makes with another when they are not at right angles. 2. An instrument consisting of two arms joined together and opening to any angle, for drawing angles or adjusting the surfaces of work to a given angle. 3. To slope or slant. (Webster)

Bevel gear. A gear wheel whose teeth are inclined to the axis of the wheel. (Steel)

Bevelment. The replacement of an edge of a crystal by two planes equally inclined to the adjacent faces. (Standard)

Bevel wheel. *See* Bevel gear.

Bewaarplaatsen (South Afr.). A site for depositing ore. (Skinner)

Bezel. A facet of a gem. (Standard)

Biard. *See* Bearers, 2.

Biat; Byat (Eng.). A timber stay or beam in a shaft (Gresley). *See also* Bearers, 2.

Biaxial. Having two optic axes or lines of no double refraction. (Webster)

Bibbles (Derb.). A soft water-bearing stratum encountered during shaft sinking. (Hooson)

Bibbley rock (So. Staff.). A conglomerate or pebbly rock (Gresley)

Bibliolite. A laminated schistose rock; a bookstone. (Standard)

Bica (Braz.). An inclined portion of a sluice. (Halse)

Bicarbonate. A salt of carbonic acid in which but one of the hydrogen atoms is replaced by a base; as bicarbonate of soda $NaHCO_3$, called also Monocarbonate, Primary carbonate, Supercarbonate. (Standard)

Bicharra (Peru). A small furnace with an inclined stack. (Dwight)

Biche (No. of Eng.). A hollow conical-headed tool for extricating broken rods from bore holes (Gresley). *See also* Beche.

Bichloride. A salt in which there are two atoms of chlorine, as bichloride of mercury, $HgCl_2$. (Standard)

Bichromate. Same as dicromate. (Standard)

Bichromate cell. A zinc-carbon cell having as the exciting fluid an acid bichromate solution and provided with the means of raising the zinc, or both zinc and carbon, from the fluid when not in use. E. M. F. about 2 volts. (Webster)

Biddix (Corn.). A double pick, with spoonbill points, used for excavating alluvial or surface earth. (Standard)

Bidri. 1. (Anglo-Ind.) A process of damaskeening with silver on a ground consisting of an alloy of copper, lead, and tin, blackened by the application of a solution of sal ammoniac, saltpeter, salt, and copper sulphate. 2. Articles made by the foregoing process; bidriware. Called also Biddery; Biddery-ware; Bidery; Bidri-work; Bidry. (Standard)

Bieberite. A vitreous, flesh-red to rose-red hydrous cobalt sulphate, $H_{14}CoSO_{11}$, crystallizing in the monoclinic system. (Dana)

Bielzite. A brittle, resinous, brownish black hydrocarbon mineral from Transylvania; it has a specific gravity of 1.249, and dissolves in considerable part in carbon disulphide and chloroform. (Bacon)

Bifurcación (Sp.). 1. The branching of a vein. 2. A branch road. (Halse)

Bifurcate. To divide into two branches (Webster). Said of an ore vein.

Bigging (No. of Eng.). A built-up pillar of stone or other débris in a working place or heading to support the roof, *e. g.* "bigging the gob" means, building a pack in a worked-out place. (Gresley)

Bigorneta (Sp.). A small anvil. (Min. Jour.)

Bigornia (Mex.). Anvil. *See also* Yunque. (Dwight)

Bigote (Sp.). A semicircular taphole in a furnace. (Halse)

Bilca (Peru). A rawhide receptacle in which filtered mercury collects. (Pfordte)

Biji timah (Malay). Small nodules in clay deposits.

Bildar (Hind.). A digger; an excavator. (Webster)

Bildas (or Buildhouse) (So. Staff.). The shift working from 6 A. M. till 9, and sometimes 10 o'clock, is termed a bildas. This was originally denominated Buildhouse, from the fact of the butty (contract miner) making so much money that he was able to build many houses from the exactions thus made upon the poor men, who received inadequate remuneration. (Min. Jour., 1871)

Bildstein (Ger.). A soft stone; agalmatolite. (Standard)

Bilitrones (Sp. Am.). A communication between washing troughs. (Lucas)

Bill day (No. of Eng.). That day on which colliery accounts are examined. (Gresley)

Billet. 1. Iron or steel, drawn from a pile, bloom, or ingot into a small bar for further manufacture. 2. A small bloom. (Raymond)
3. (Som.). A short timber prop. (Gresley)

Billeting roll. A set of rollers having flattening and edging grooves, used in rolling iron into merchantable bars. (Century)

Billon (Fr.). 1. In coinage, an alloy of gold or silver with some baser metal, generally copper or tin; specifically, a low alloy of silver with a large proportion of copper, used in making token and medals, and, in some countries, especially Austria, coins. 2. Coin struck from such an alloy. (Standard)

Billot (Fr.). Gold or silver in the mass or ingot intended for coinage. (Standard)

Billy. 1. (Forest of Dean). A box for holding ironstone, carried by a boy in the mine. 2. *See* Billy playfair. (Gresley)
3. (Aust.) A name used in the Clermont district of Queensland for a bed of quartzite that caps the coal measures. (Power)

Billy boy. A boy who attends a Billy playfair. (C. and M. M. P.)

Billy playfair; Fair-play (Wales). A mechanical contrivance for weighing small coal which passes through the screen. (Gresley)

Bimbalete (Peru). A crude ore-mill operated by two men. The grinder is a large stone with a transverse bar by which a rocking motion is given. Also called Quimbalete. (Dwight)

Bimetalism. The concurrent use of both gold and silver as money at a fixed relative value, established by law; also, the doctrine advocating such use. (Standard)

Bin. A box, frame, crib, or inclosed place used as a receptacle for any commodity, as coal, ore, etc. (Webster)

Bina (Eng.). Hard clayey substance (Bainbridge). A variety of bind.

Binary granite. A term more or less used in older geological writings for those varieties of granite that are chiefly quartz and feldspar. It has recently been applied to granites containing two micas. (Kemp)

Binches (Arg.). Crystals of pyrite occurring in a gold-bearing conglomerate. (Halse)

Binching. 1. (Som.). The stone upon which a bed of coal rests. (Gresley)

Bind; Binds; Bend (Derb.). 1. Indurated argillaceous shale or clay, very commonly forming the roof of a coal seam and frequently containing clay ironstone. 2. (No. of Eng.) To hire. (Gresley)

Binder. 1. (Corn.). Beds of grit in shale, slate, or clay. *See also* Bind, 1 (Power). A streak of impurity in a coal seam, usually difficult to remove.
2. (Corn.). An underground carpenter. (Davies)
3. Anything which causes cohesion in loosely assembled substances, as cement in a wall, crushed stone in a macadam road, fire clay in a graphite crucible, etc. (Webster)
4. The course, in a sheet-asphalt pavement, frequently used between the concrete foundation and the sheet-asphalt mixture of graded sand and asphalt cement. (Bacon)

Bindheimite. A hydrous antimonate of lead; an oxidation product of jamesonite. (U. S. Geol. Surv.)

Binding. 1. (No. of Eng.). Hiring of men for pit work. (Gresley)
2. A band of masonry so laid as to fasten together or strengthen adjoining parts. (Webster)

Binding bolts (Scot.). Bolts used to secure machinery to the foundations. (Barrowman)

Binding coal. Coal which cakes on burning. (Bacon)

Bin feeder. A man who rods or bars ore that sticks as it passes through the bin door. (Willcox)

Bing. 1. (No. of Eng.). A pile or heap of anything. Specifically: A heap of metallic ore, etc. 2. The kiln of a furnace for making charcoal used in metal smelting (obsolete). (Standard)
3. Eight hundred weight of ore. (Raymond)
4. (Eng.). The best quality of lead ore. (Webster)
5. (Scot.). A place where coal is stocked, or débris is piled at the surface. 6. To put coal in wagons or in stacks at the surface. (Gresley)

Bing-hole (Derb.). A hole or chute through which ore is thrown. (Raymond)

Bing ore (Derb.). The largest and best kind of lead ore. (Hunt)

Bingplace (Derb.). The place where ore is stored for smelting. (Min. Jour.)

Bingstead (Eng.). 1. The place where lead ore is dressed. (Hunt)
2. A place for storing ore, coal, etc. *Compare* Bing, 1 and 5.

Bing-tale (No. of Eng.). A synonym for Tribute.

Bin man. One who pokes down ore in bins to keep it feeding through the chutes. (Willcox)

Binnite. A dark steel-gray metallic copper sulpharsenite, $Cu_6As_4S_9$, that crystallizes in the isometric-tetrahedral system. (Dana)

Biotite. A magnesium-iron mica. The common black mica. Often used as a prefix to many names of rocks that contain this mica; such as biotite-andesite, biotite-gneiss, biotite-granite, etc. (Kemp)

Bipyramid. In crystallography, a double-ended pyramid. (A. F. Rogers)

Biquartz. A quartz plate of two sections which turn the plane of polarization in opposite directions. It is used with a polariscope. (Webster)

Bird's eye marble. A local name given to several varieties of marble in which the markings assume the appearance of a bird's eye. (Merrill)

Bi-refringence. The property possessed by crystals belonging to other than the isometric system of splitting a beam of ordinary light into two beams which traverse the crystal at different speeds, and as they pass out of it produce characteristic optical effects that are recognizable with the proper instruments or, in some cases, by the eye alone. Bi-refringence is also known as Double refraction. (Ransome)

Birmite. *See* Burmite.

Bischofite. A crystalline-granular and foliated, colorless to white hydrous magnesium chloride, $H_{12}MgCl_2O_6$. (Dana)

Biscuit. In ceramics, ware baked once, but not glazed; bisque. (Standard)

Bisectrix. A line bisecting the angle between the optic axes of a biaxial crystal. *See* Acute bisectrix; *also* Obtuse bisectrix. (Webster)

Bismite. Bismuth trioxide, Bi_2O_3, occurring as a straw-yellow earth, and as pearly white scales. (Dana)

Bismuth. One of the elements. A brittle, reddish white metal. Symbol, Bi, atomic weight, 208.0. Specific gravity, 9.8 (Webster). The reddish-color is possibly due to oxidation.

Bismuth blende. Same as Eulytite. (Standard)

Bismuth bronze. An alloy of bismuth with tin. (Standard)

Bismuth flux. A mixture of one part potassium iodide, one part acid potassium sulphate, and two parts of sulphur. Also made by mixing equal parts of potassium iodide and sulphur.

Bismuth glance. *See* Bismuthinite.

Bismuthinite. Bismuth trisulphide, Bi_2S_3. Contains 81.2 per cent bismuth. (Dana)

Bismuthite. *See* Bismutite.

Bismuth ocher. *See* Bismite.

Bismuth silver. 1. Same as Chilenite. 2. Same as Schapbachite. (Standard)

Bismutite. A basic bismuth carbonate of doubtful composition. Perhaps $Bi_2O_3.CO_2H_2O$. Contains 80 per cent Bismuth. (Dana)

Bismuto (Mex.). Bismuth. (Dwight)

Bismutosphärite. A yellow, spherical, fibrous bismuth carbonate, Bi_2CO_5, usually found as an alteration product of bismuthinite. (Dana)

Bisphenoid. In crystallography, a form apparently consisting of two sphenoids placed together symmetrically. (A. F. Rogers)

Bisque. In ceramics, biscuit; biscuit-ware, as in statuettes, dolls, etc. (Standard)

Bit. 1. A drilling chisel. *Compare* Auger-stem. (Chance)
2. The cutting end of a boring implement. (Raymond)
3. A pointed hammer for dressing hard stone, as granite. 4. The blade of an ax. 5. The copper head of a soldering iron. (Webster)

Bitches (Scot.). A set of three chains for slinging pipes in a mine shaft. (Barowman)

Bites (Colom.). Slime produced by grinding or stamping ore. (Halse)

Bitter. Applied to minerals having the taste of Epsom salts. (Dana)

Bitter earth. Magnesia.

Bittern. The bitter mother liquor that remains in salt works after the salt has crystallized out. (Webster)

Bitter spar. A pure, crystalline dolomite. It consists of one part or equivalent of calcium carbonate and one part of magnesium carbonate. Also called Pearl spar. (Roy. Com.)

Bitulithic. A kind of paving consisting of broken stone cemented with bitumen or asphalt. (Webster)

Bitumastic. A kind of bituminous paint or cement. (Webster)

Bitumen. *See* Asphalt. A general name for various solid and semisolid hydrocarbons. In 1912 the term was used by the American Society for Testing Materials to include all those hydrocarbons which are soluble in carbon bisulphide, whether gases, easily mobile liquids, viscous liquids, or solids. (U. S. Geol. Surv.)

Bitumenized. Converted into bitumen. (Hitchcock)

Bituminate. 1. To cement or cover with bitumen. 2. To charge or mix with bitumen. (Standard)

Bituminiferous. Yielding or containing bitumen. (Standard)

Bituminoso (Mex.). Bituminous. (Dwight)

Bituminous. 1. Containing much organic, or at least carbonaceous matter, mostly in the form of the tarry hydrocarbons which are usually described as bitumen. (Kemp)
2. Having the odor of bitumen. Often applied to minerals. (Dana)

Bituminous cement. A bituminous material suitable for use as a binder, having cementing qualities which are dependent mainly on its bituminous character. (Bacon)

Bituminous coal. Ordinary soft coal. *See* Coal.

Bituminous limestone. A limestone impregnated with bituminous matter and emitting a fetid odor when rubbed. Called also Stinkstone and Swinestone. (Standard)

Bituminous pavement. A pavement composed of stone, gravel, sand, shell or slag, or combinations thereof, and bituminous materials, thoroughly incorporated. (Bacon)

Bituminous sandstone. *See* Sandstone.

Bituminous shale. A shale containing hydrocarbons or bituminous material: when rich in such substances it yields oil or gas on distillation. Called also Pyroschist or Oil shale. (Standard)

Bituminous surface. In paving, a superficial coat of bituminous material, with or without the addition of stone or slag chips, gravel, sand, or material of similar character. (Bacon)

Bituminous wood. A variety of brown coal much resembling wood. (Chester)

Bitusol. Trinidad asphalt. It is said to be a true bitusol—that is to say, dispersed solid colloids in solution in bitumen. (Bacon)

Bivalent. Having a valence of two. *See also* Valence. (Webster)

Bizen ware. Fine, hard, unglazed pottery, usually grayish white; made in Bizen, Japan. (Webster)

Bizet. In gem cutting, the part of a brilliant (diamond) between the table and the girdle, occupying one-third of its depth and having 32 facets. (Standard)

Black alta. An argillaceous schist, found in the New Almaden quicksilver mine, Santa Clara County, California. (Hanks)

Black amber. A name given by amber-diggers to jet which is found with amber. It becomes faintly electric when rubbed. (Oldham)

Black and gold marble. *See* Porto marble.

Black ash. A solid black mixture of sodium carbonate and calcium sulphide produced by fusing sodium sulphate, limestone, and coal together in soda-ash manufacture. Called also Soda-ball and British barilla. (Standard)

Blackband. An earthy carbonate of iron, accompanying coal beds. Extensively worked as an iron ore in Great Britain, and somewhat in Ohio. (Raymond)

Black bat. A piece of bituminous shale embedded in the rock immediately over the coal measure and liable to fall of its own weight when the coal beneath it has been removed (Cinkovitch v. Thistle Coal Co., 143 Iowa, p. 597, 121 Northwestern, 1036). *Compare* Kettle bottom; Bell-mold.

Black butts. Discolored and imperfect coke, usually found at the bottom or side of the oven because of excessive moisture existing there; may also result from improper manipulation of the oven. Also called Black ends.

Black chalk. 1. A variety of bluish-black clay containing carbon. (Skinner)
2. A slate sufficiently colored by carbonaceous particles to answer the purpose of black lead in pencils for coarse work, such as marking stone. (Century)

Black coal (Scot.). Coal slightly burned by igneous rock (Barrowman). *See* Natural coke; Blind coal, 1.

Black copper. A name given to the more or less impure metallic copper produced in blast-furnaces when running on oxide ores or roasted sulphide material. It is always an alloy of copper with one or more other metals generally containing several per cent of iron, often lead, and many other impurities. It also contains from 1 to 3 per cent sulphur. (Peters, p. 227)

Black copper ore. *See* Melaconite; Tenorite.

Black coring. The development of black or bluish-black cores in bricks, due to improper burning. (Ries)

Black cotton (India). Soil from 6 to 10 feet in thickness overlying the coal measures, which in dry weather shrinks and produces mud cracks. (Gresley)

Black damp. A term generally applied to carbon dioxide. Strictly speaking, a mixture of nitrogen, and carbon dioxide. The average black damp contains 10 to 15 per cent carbon dioxide, and 85 to 90 per cent nitrogen. It is formed by mine fires and the explosion of fire damp in mines, and hence forms a part of the afterdamp. An atmosphere depleted of oxygen rather than containing an excess of carbon dioxide.

Black diamond. 1. A variety of diamond, opaque, dark colored, and without cleavage. (Moses)
2. A term frequently applied to coal. (Gresley)

Black earth. A kind of coal which is pounded fine and used by painters in fresco. (Century)

Black-ends (Eng.). *See* Black butts.

Blackening. In founding, the process of coating the faces of a mold with charcoal or similar fine powder, or with a mixture thereof with water; facing. (Standard)

Black flux. A flux obtained as a dark colored mass (consisting of potassium carbonate and finely divided carbon) by the deflegration of tartar with about half its weight of saltpetre. (Webster)

Black heat. A heat just below a dull red heat, at which iron or steel turns black (Webster). *Compare* Black-red heat.

Black hematite. A synonym for Psilomelane. (Chester)

Black horse. A term used by quarrymen in Rhode Island to denote a dark biotite-gneiss in contact with the granite. (Dale)

Blacking. Finely powdered charcoal, graphite, or a mixture thereof with water, or other form of powdered carbon, used in coating a mold, as in iron casting; blackwash; facing. (Standard)

Black iron. Malleable iron untinned: distinguished from Tinned or White iron. (Standard)

Black iron ore. A synonym for Magnetite. (Chester)

Blackjack. 1. A dark variety of zinc-blende or sulphide of zinc. It has a resinous luster and yields a light colored streak or powder. *See also* Blende; Sphalerite. (Dana)
2. Crude black oil used to lubricate mine-car wheels. 3. (Ark.) Soft black, carbonaceous clay or earth associated with coal. (Steel)
4. (Derb.) A kind of cannel coal. (Gresley)
5. (Ill.) A thin stratum of coal interbedded with layers of slate. A poor, bony coal.

Black latten. Milled sheet brass as used by braziers and wiredrawers. (Standard)

Blacklead. The common name for graphite, because it gives a mark on wood or paper like that of metallic lead. Also called Plumbago. (Roy. Com.)

Blacklead ore. An early name for the black variety of cerussite. (Chester)

Blackleg. 1. A strike breaker. 2. A swindler; a dishonest gambler. (Webster)

Black lignite. A coal intermediate between lignite and bituminous coal and not always distinguishable from one or the other on sight. Called also Subbituminous coal. (Watson)

Black list. Any list of persons who are for any reason deemed objectionable by the makers or users of the list, as for political or social misconduct, for joining in or assisting a strike, etc. (Century)

Black litharge. *See* Abstrich.

Blacklung. *See* Anthracosis.

Black-mob (Eng.). Slang for workmen who refuse to join a trades union. (Standard)

Black muck; Black mould (Lanc.). A dark-brown powdery substance, consisting of silica, alumina, and iron; found in iron mines. (Gresley)

Black ocher. Wad; bog manganese ore.

Black oil. A residue from petroleum or from its distillates. It varies widely in character and is used as a cheap lubricant. (Bacon)

Black ore (Eng.). Partly decomposed pyrite containing copper. (C. and M. M. P.)

Black oxide of manganese. *See* Pyrolusite.

Black pigment. Lampblack obtained by burning common coal tar. (Century)

Black plate. Sheet iron before tinning. (Raymond)

Blackpot (Eng.). A variety of coarse unglazed pottery. (Standard)

Black powder. A granular explosive containing approximately 74 per cent potassium nitrate, 16 per cent wood charcoal, and 10 per cent sulphur. For sporting powders the per cent of potassium nitrate is usually a little higher. *Compare* Blasting powder. (Brunswig, p. 238)

Black-red heat. The temperature of a metal at which it begins to be luminous by daylight (Standard). *Compare* Black heat.

Black-ring (So. Staff.). A thin bed of coal as seen in the shaft sides, having the appearance of a black circle or ring. (Gresley)

Blacks (Som.). Soft dark-colored shale. (Gresley)

Black sand. Heavy grains of various minerals which have a dark color, and are usually found accompanying gold in alluvial deposits, *e. g.*, magnetite, chromite, ilmenite, cassiterite, tourmaline, etc. (Power)

Black-sand beach. A beach where black sand occurs.

Black silver; Brittle silver ore. Same as Stephanite. (Standard)

Black solder. An alloy of copper, zinc, and a little tin. (Webster)

Blackstone (No. of Eng.). Highly carbonaceous shale. (Gresley)

Blackstrap. A dark, heavy oil used for lubricating mine-car wheels. *See also* Black jack, 2.

Black taggers. Thin sheet iron uncoated with tin. Black iron. (Standard)

Black telluride. *See* Nagyagite.

Black tin (Corn.). Dressed tin ore ready to be smelted. (Standard)

Black truck (Aust.). A box-shaped truck or car with end door, so called because it is made black with tar. (Power)

Black vitriol. An impure copper sulphate. (Standard)

Black wad. An early name for several minerals, including graphite and the softer manganese oxides. (Chester)

Blackwork. 1. Iron wrought by blacksmiths. 2. Forgings, rolled work, etc., which have not undergone a process that gives a bright finish. (Webster)

Bladed. Decidedly elongated and flattened (Butler). Said of some minerals.

Bladed structure. Consisting of parts resembling knife blades. (George)

Blae. 1. (Scot.) A hard sandstone, free from joints; also an underclay with balls of ironstone. *See* Bind. Called Blaes or Blaize (Gresley). 2. A soft shale or slate of bluish color (Webster). *See* Kingle.

Blagden's law. The law (of limited application) that the lowering of the freezing point is proportional to the amount of the dissolved substance. (Webster)

Blair process. An improved form of the Chenot process. (Raymond)

Blaisdell reclaiming apparatus. An apparatus for automatically discharging a sand tank having a central bottom opening. It consists of a central vertical shaft carrying four arms fitted with round plow disks. Sand is plowed toward a central opening and discharged on a conveyor belt (Liddell). Also called Blaisdell vat excavator.

Blaisdell sand distributer. An apparatus for loading sand tanks. It consists of a rapidly revolving disk with curved radial vanes. The disk is hung on a shaft in the center of the tank, and as sand is dropped on the disk it is distributed over the entire area. (Liddell)

Blaize (Scot.). *See* Blae.

Blake crusher. The original crusher of jaw type. A crusher with one fixed jaw plate and one pivoted at the top so as to give the greatest movement on the smallest lump (Richards, p. 1200). Motion is imparted to the lower end of the crushing jaw by toggle joint operated by eccentric.

Blake furnace. A furnace, the hearth of which consists of terraces rising from the outer edge to the center. The hearth is circular and revolves when in operation. (Ingalls, p. 116)

Blanc. In ceramics, an undecorated piece of pottery. (Standard)

Blanc fixe. A barium sulphate formed artificially as a heavy, white, insoluble precipitate. Used as a pigment. Also called Baryta white; Permanent white. (Webster)

Blanch. 1. (Eng.) Lead ore, mixed with other minerals. (Raymond) 2. To cover sheet iron with a coating of tin. (Webster)

Blanched copper. An alloy of copper and arsenic. (Raymond)

Blandura (Sp.). Soft, crumbly ground. (Halse)

Blanket. 1. A piece of cloth used in blanket sluices. (Webster) 2. *See* Blanket deposit; Blanket vein. 3. A bituminous surface of appreciable thickness generally formed on top of a roadway by the application of one or more coats of bituminous material and sand (Bacon). Also called Carpet.

Blanket deposit. A flat deposit of ore of which the length and breadth are relatively great as compared with the thickness. The term is current among miners, but it has no very exact scientific meaning. More or less synonymous terms are flat sheets, bedded veins, beds or flat masses. Such deposits are frequently intercalated between rocks of different lithological character and origin, and may have been deposited in a regular sedimentary series, or subsequently introduced between the beds or impregnating them (Century) *See also* Blanket vein.

Blanketing. 1. Material caught upon the blankets used in concentrating gold-bearing sands or slimes. (Webster) 2. The process involved in definition 1.

Blanket shooting. Also termed Buffer shooting or Shooting against the bank. A term applied to a method of blasting on a face not exceeding 30 or 35 feet in height. It involves leaving at the quarry face a mass of shattered rock several feet in thickness that serves as a buffer, preventing the rock from being thrown far from its source, and also rendering the shot more effective. (Bowles)

Blanket sluice. A sluice in which coarse blankets are laid, to catch the fine but heavy particles of gold, amalgam, etc., in the slime passing over them. The blankets are removed and washed from time to time, to obtain the precious metal. (Raymond)

Blanket table, or strake (Aust.). A sloping board or table covered with baize for catching gold. (Davies)

Blanket vein. A horizontal vein or deposit. Sheet ground. A sheet deposit. "A vein in which the ore body covers the entire area within the limits of the surface lines of a mining location. The apex of a blanket vein is coextensive with the space between the side lines of a mining location." (Homestake Min. Co., In re, 29 Land Decisions, p. 689; Belligerent, etc., Mining Claims, In re, 35 Land Decision, p. 22.) (U. S. Min. Stat., p. 106). *See also* Blanket deposit.

Blanton cam. A device used for locking the cam on the camshaft in a stamp-mill. A wedging action is insured by means of a brass taper bushing.

Blast. 1. The operation of blasting, or rending rock or earth by means of explosives. 2. The air forced into a furnace to accelerate combustion 3. The period during which a blast furnace is in blast, that is, in operation. (Raymond)
4. An explosion of gas (or dust) in a mine. (Webster)
5. (Scot.). A fall of water in the down-cast shaft to produce or quicken ventilation. (Barrowman)
6. To give (a kiln) a specially hot firing at the last. (Standard)

Blast box. A chamber into or through which the air of a blowing engine passes. (Century)

Blast draft. The draft produced by a blower, as by blowing in air beneath a fire, or drawing out the gases from above it. A forced draft. (Webster)

Blasted. 1. A term applied to a miner who has been injured by an explosion of dynamite or gunpowder. (Weed)
2. Rent by an explosive. (Webster)

Blast furnace. A furnace in which combustion is forced by a current of air under pressure, especially for smelting ores. A blast furnace is designated as hot-blast or cold-blast according to the temperature of the air used for the blast. The furnace is usually vertical, but varies greatly in size and shape (Webster)

Blast hearth. A hearth in connection with which a blast is used, as in reducing lead ore. (Webster)

Blast-hole (Eng.). 1. The holes through which the water enters the bottom of a pump (Ure). *See also* Snore hole.
2. A hole for a blasting-charge. (Standard)

Blast-hole machine. A drilling machine of the Keystone type, used to drill holes 6 in. diameter and 35 to 40 ft. deep for the purpose of blasting down a large amount of ore or waste in advance of the steam-shovels. It is used in all of the great excavations of the disseminated copper deposits. (Min. and Sci. Press, vol. 113, p. 946.)

Blasting. 1. The operation of splitting rocks by gunpowder or other explosives (Century): as in mining and quarrying operations.
2. A method of loosening or shattering masses of solid matter, encountered during boring, by means of explosive compounds. Where petroleum occurs in a dense hard rock, recourse must sometimes be had to the use of explosives, the effect of these being to set up a subterranean disturbance, which may thus be the means of giving free movement to the oil. (Mitzakis)

Blasting barrel. A piece of iron pipe usually about ½ inch in diameter used to provide a smooth passage way through the stemming for the miner's squib. It is recovered after each blast and used until destroyed (Du Pont)

Blasting cap. A copper shell closed at one end and containing a charge of detonating compound, which is ignited from the spark of the fuse. Used for detonating high explosives (Du Pont)

Blasting cartridge. A cartridge containing an explosive to be used in blasting. (Webster)

Blasting circuit. The leading wires, connecting wires and connected electric blasting caps, when prepared for the firing of a blast. (Du Pont)

Blasting compounds. Explosive substances used in blasting. (Century)

Blasting fuse. A slow burning fuse used for igniting blasting charges. (Webster)

Blasting gelatin. A high explosive, consisting of nitroglycerin and nitrocotton. It is a strong explosive, and is a rubber-like, elastic substance, unaffected by water. (Du Pont)

Blasting machine. A portable dynamo, in which the armature is rotated by the downward thrust of the rack-bar or handle, used for firing blasts electrically (Du Pont). Also called Battery.

Blasting mat. A tightly woven covering of heavy manila rope or wire rope, or chain, made in various sizes, for covering the material to be blasted and preventing the flying of small fragments of rock. (Du Pont)

Blasting needle. A needle-like instrument for making an opening for a fuse (or squib). (Webster)

Blasting oil. Same as Nitroglycerin. (Century)

Blasting powder. A powder containing less nitrate, and in its place more charcoal than black powder. Its composition is 65 to 75 per cent potassium nitrate, 10 to 15 per cent sulphur and 15 to 20 per cent charcoal. In the United States sodium nitrate is largely used in place of the potassium salt. *Compare* Black powder. (Brunswig, p. 302)

Blasting stick. A simple form of fuse. (Raymond)

Blasting supplies. A term used to include electric blasting caps, ordinary blasting caps, fuse, blasting machines, galvanometers, rheostats, etc., in fact, everything used in blasting, except explosives. (Du Pont)

Blasting tube. An India rubber tubing used for holding nitroglycerin. (Webster)

Blast liquor. A liquid for bleaching; as a solution of chloride of lime. (Webster)

Blast meter. An anemometer for measuring the force of a blast. (Webster)

Blast nozzle. A fixed or variable outlet of a blast pipe. (Webster)

Blast pipe. A pipe for supplying air to furnaces. (C. and M. M. P.)

Blast-roasting. A generic term given by A. S. Dwight to a process of forcing air through finely divided metallic sulphides with the object of roasting and agglomerating in a single operation. The process which originated with Huntington and Heberlein in 1889 was confined to a galena concentrate, limestone being added to serve both as a diluent to keep separate the particles of galena that they might be thoroughly oxidized, and as a flux that the partly roasted ore might be agglomerated by the formation of a sinter. In the original Huntington and Heberlein process the galena concentrate, mixed with limestone, is given a preliminary rough-roast, in order to oxidize some of the sulphide and thus reduce its calorific power, before it is moistened and charged into the converting pot.
In the later Savelsberg process the moistened galena-limestone mixture is blown direct without having been subjected to a rough-roast.
In the third modification, the Carmichael-Bradford process, the mode of operating is the same as with the Savelsberg, only limestone is replaced by dehydrated gypsum. These three established processes, as well as some other modifications, are characterized as the up-draft operations and are usually intermittent; the Dwight-Lloyd process is the leading representative of the down-draft operation which is usually continuous. (Hofman, General Metallurgy, pp. 411–412)

Blatt (Ger.). A flaw or fault.

Bleacher. A settling tub used in refining petroleum. (Standard)

Bleaching clay (Corn.). Kaolin, used with size, to whiten and give weight and substance to cotton goods. (Raymond)

Bleaching powder. A powder for bleaching, as chloride of lime, or calcium oxychloride $CaOCl_2$. (Webster)

Bleb. A vesicle or bulla containing a serous fluid; a bubble as in water, glass, etc. (Webster)

Bleck. 1. (No. of Eng.) Pitch or tar upon ropes. (Gresley)
2. A black, fluid or semifluid substance, as blacking for leather, grease on an axle, etc. (Standard)

Bleed (Eng.) To give off water, or gas, as from coal or other stratum. (Gresley)

Bleeder. 1. An escape valve for gas at the top of a furnace or along the gas line, to relieve excess pressure or flow of gas. (Willcox)
2. A small cock or valve to draw off water of condensation from a range of piping. (Nat. Tube Co.)

Bleeding. The exudation of bituminous material on the roadway surface after construction. (Bacon)

Bleeding valve. A cock, as in an air brake mechanism, the opening of which releases air (Standard). *See also* Bleeder.

Bleiberg furnace. *See* Carinthian furnace.

Blenda (Mex.). Zincblende. (Dwight)

Blende. Without any qualification means zincblende or the sulphide of zinc, which has the luster and often the color of common resin, and yields a white streak and powder. The darker varieties are called blackjack by the English miners. Other minerals having this luster are also called blendes, as antimony blende, ruby blende, pitchblende, hornblende (Roy. Com.). It is often found in brown shining crystals, hence its name among the German miners, from the word *blenden* to dazzle.

Blick (Ger.). The brightening or iridescence appearing on silver or gold at the end of the cupelling or refining process. (Raymond)

Blikhuis (So. Afr.). A small house of galvanized iron erected on a gold field or in a diamond compound. (Standard)

Blind. 1. Not appearing in an outcrop at the surface; applied to mineral veins. (Webster)
2. (Forest of Dean.) *See* Afterdamp. 3. (Scot.). To erect a stopping in a crosscut or other underground roadway. (Gresley)

Blind coal (Eng.). 1. Coal altered by the heat of a trap dike so as to resemble anthracite. (Gresley)
2. Anthracite and other kinds of coal that burn without flame. (Power)

Blind creek (Aust.). A creek that is dry, except in wet weather. (Davies)

Blind drift. A horizontal passage, in a mine, not yet connected with the other workings (Ihlseng). *See also* Blind level.

Blinde. Same as Blende. (Standard)

Blinded (Scot.). Not opposite. Two ends (drifts or entries) driven from opposite sides of a plane and not opposite each other, but nearly so, are said to be blinded. (Barrowman)

Blind flange. A flange used to close the end of a pipe. It produces a blind end which is also called a dead end. (Nat. Tube Co.)

Blind joint. An obscure bedding plane. (C. and M. M. P.)

Blind lead; Blind lode. A vein having no outcrop. (Ihlseng)

Blind level. 1. A level not yet connected with other working. 2. A level for drainage, having a shaft at either end, and acting as an inverted siphon. (Raymond)

Blind lode. A lode showing no surface outcrop, and one that can not be found by any surface indications. *See also* Blind lead. (Skinner)

Blind-pit (Lanc.). *See* Drop-staple.

Blind road; Blind way (Mid.). Any underground roadway not in use, having stoppings placed across it. (Gresley)

Blind roaster. A muffle furnace. (Webster)

Blind seams. Incipient joints. (Ries)

Blind shaft. A shaft which does not open to daylight. A winze. *See also* Underground shaft.

Blind shearing (Scot.). A side cutting without under cutting. (Barrowman)

Blind stope (Local, U. S.). A secret working to remove ore. (Standard)

Blind vein. A vein that does not continue to the surface (Power). *See also* Blind, 1; Blind lode, Blind lead.

Blister. *See* Blister copper.

Blister copper. A high-grade crude copper in which nearly all the oxidizable impurities have been removed by slagging and volatilization. It contains from 97 to 99 per cent copper and only .25 to .75 per cent sulphur (Peters, p. 226).

Blistered copper ore. A reniform variety of chalcopyrite. (Power)

Blistering. *See* Secondary blasting; *also* Mudcap.

Blister steel. Crude steel formed from wrought iron by cementation. So called from its blistered surfaces (Webster). *See also* Cement steel.

Bloat. A hammer swelled at the eye. (Raymond)

Block. 1. A division of a mine, usually bounded by workings but sometimes by survey lines or other arbitrary limits. (Webster)

Block-bond. A style of bricklaying in which the bricks are laid crosswise and lengthwise alternately. (Standard)

Block caving. A method of mining ore from the top down in successive layers of much greater thickness than characteristic of top slicing. Each block is undercut over the greater part of its bottom area and the supporting pillars blasted out. As the block caves and settles, the cover follows. The method might be considered as involving many of the features of top slicing combined with ore caving, but applied on a larger scale (Young). Also called "Caving system" and "Cumberland method of mining."

Block caving into chutes. *See* Chute caving.

Block claim (Aust.). A square mining claim whose boundaries are marked out by posts. (Skinner)

Block coal. A peculiar kind of coal that breaks into large cubical blocks. It is used raw, or without coking, in the smelting of iron. Found in the Indiana coal field. (Century)

Block furnace. Same as Bloomery. (Century)

Block hole. 1. A small hole drilled in a block of rock either by hand drill or a portable air drill, to contain a small charge of explosive. 2. A relief hole, designed to remove part of the burden from a subsequent shot, used in coal mining. (Du Pont)
2. A quarryman's term for a method of breaking undesirably large blocks of stone by the discharge of dynamite in shallow holes. (Bowles)

Blockholer. A person whose duty it is to break up and reduce to safe and convenient size, by blasting or otherwise, any large blocks or pieces of rock that have been blown down by the miners. (Mesich v. Tamarack Mining Co., 184 Michigan, p. 366; 151 Northwestern, p. 563)

Blocking-out. 1. (Aust.). Laying or staking out gold-bearing gravel deposits in square blocks in order to facilitate systematic washing. 2. Exposing an ore body on three sides. (Skinner)

Block ore. A local term in Wisconsin for large cubical crystals of galena. (Power)

Block-reef (Aust.). A reef that shows frequent contractions and bulges. A wavy vein. (Power)

Block system of stoping and filling. *See* Overhand stoping.

Block tin. Commercial tin, cast into blocks, and partly refined. Solid tin as distinguished from tin plate. Also called Bar tin. (Webster)

Blocky. Breaking down in thick blocks. Applied to the roof of a mine working. (Steel)

Blond-metal (Staff.). A variety of clay ironstone of the coal-measures occurring near Wednesbury. (Century)

Blood poisoning. A morbid state of the blood caused by the introduction of poisonous or infective matter from without, or the absorption or retention of such as is produced in the body itself. (Webster)

Bloodstone. A variety of chalcedony or jaspar, dark green in color, interspersed with small red spots. Used as a gem. (U. S. Geol. Surv.)

Bloodwipe (Derb.). To draw blood, at a mine, by any act of violence that one man can inflict upon another. (Hooson)

Bloom. 1. A large steel bar, drawn from an ingot for further manufacture. 2. A rough bar of iron, drawn from a Catalan or bloomery ball, for further manufacture. *See also* Billet. (Raymond)
3. A mass of iron or steel formed by consolidating scrap at a high temperature by hammering or rolling. 4. A lump or mass of molten glass. 5. An earthy mineral that is frequently found as an efflorescence, as cobalt bloom. Also called Blossom. 6. To form an efflorescence, as salts with which alkali soils are impregnated bloom out on the surface of the earth in dry weather, after a rain or irrigation. 7. The fluorescence of petroleum. (Webster)

Bloomery; Bloomary. 1. A forge for making wrought-iron, usually direct from the ore. The sides are iron plates; the hair plate at the back. the cinder plate at the front, the tuyère plate (through which the tuyère passes) at one side (its upper part being called in some bloomeries the merrit plate) the fore-spar plate opposite the tuyère plate (its upper part being the skew plate) and the bottom plate at the bottom. (Raymond)
2. A machine for making blooms out of puddle-balls; an establishment containing such machines. (Standard)

Bloom hook. A tool for handling metal blooms. Also called bloom tongs. (Century)

Blooming. The process of manufacturing blooms of iron from the ore or from puddle balls. (Standard)

Blooming mill. 1. The first set of rolls in a rolling mill. 2. A bloomery. (Standard)

Blossom. The oxidized or decomposed outcrop of a vein or coal bed, more frequently the latter. Also called Bloom, Smut, and Tailing. *See also* Gossan. (Raymond)

Blossom of coal. *See* Coal smut, 1.

Blossom rock. The rock detached from a vein but which has not been transported. (Ihlseng)

Blout. A mass of quartz, often mineralized, that is frequently isolated and not connected with a vien. A contraction of Blow-out, 2.

Blow. 1. A single heat or operation of the Bessemer converter, also the quantity of metal operated upon. 2. (Aust.). A large mass of quartz or other gangue, isolated or forming a sudden enlargement on a lode. (Webster)
3. (Eng.). To blast with powder. 4. The escape of gas through a dam or stopping. 5. (York.). The breaking or falling of a mine roof. (Gresley)
6. (Aust.). The outcrop of the top of a vein (Standard). *See* Ironstone blow.

Blowdown (Eng.). To bring down coal or stone with explosives. (G. C. Greenwell)

Blowdown fan. A force fan. (C. and M. M. P.)

Blower. 1. A fan or other apparatus for forcing air into a furnace or mine. *See* Blowing engine. (Hanks)
2. A blowing out or forcible discharge of gas from a hole or fissure in a mine. (Webster)
3. (Eng.). A man who blasts or fires shots in a mine, or who drills the holes and charges them, ready for firing. (Gresley)
4. A foreman in charge of the operation of a blast furnace and stoves. At small plants in charge of trestle, stock house, and pig machine as well. (Willcox)

Blow-George (Eng.). A small centrifugal fan worked by hand, for mine ventilation. (Gresley)

Blowholes. 1. Minute craters formed on the surface of thick lava flows. (Daly)
2. A hole for the escape of gas or air. 3. A spot in a casting weakened by a bubble of air; an air hole. (Webster)

Blow-in. To put a blast furnace in operation. (Raymond) *See also* Blowing-in.

Blowing (Eng.). Blasting. (Bainbridge)

Blowing engine. An engine for forcing air into blast furnaces under pressure, often about one pound avoirdupois per square inch. (Weed)

Blowing fan. A rotary fan used to produce a blast. (Webster)

Blowing furnace. A furnace in which glassware is held to soften it when it becomes stiff in working. (Webster)

Blowing house (Eng.). An establishment in which blast furnaces are operated (Ure). Specifically for smelting tin ore.

Blowing-in. The starting of a furnace which consists of warming the crucible, filling the furnace and heating the charge to the smelting point. (Hofman, p. 319)

Blowing on tap hole. Blowing air through the hole at casting, to clean the hearth of iron and cinder. (Willcox)

Blowing on the monkey. A flame blowing from the cinder notch of a blast furnace. (Willcox)

Blowing-out. *See* Blow-out, 1.

Blowing pipe. A glass-blower's pipe. (Century)

Blowing-pot. In pottery works, an apparatus for distributing color over the ware before burning. (Century)

Blowing road (So. Staff.). An intake, or fresh-air road in a mine. (Gresley)

Blowing tools. A small set of blasting implements (Standard). *Compare* Blasting supplies.

Blowing-up furnace. A furnace used for sintering ore and the volatilization of lead and zinc. (Hofman, p. 139)

Blown-out shot. A shot that has blown out the stemming without breaking any of the coal except that around the auger hole (Steel). *See also* Blow-out, 3.

Blow-off. 1. To let off excess of steam from a boiler. (C. and M. M. P.) 2. To blow out, by means of a special valve, the suspended and precipitated impurities collected in a steam boiler.

Blow-out. 1. To put a blast furnace out of blast, by ceasing to charge fresh materials, and continuing the blast until the contents of the furnace have been smelted. 2. A large outcrop, beneath which the vein is smaller, is called a blow-out. 3. A shot or blast is said to blow out when it goes off like a gun and does not shatter the rock (Raymond). A blown-out or windy shot.
4. A sudden or violent escape of gas, or air. 5. The cleaning of boiler flues by a blast of steam. (Webster)
6. The rupture of a boiler tube, steam pipe, pneumatic tire or other container through faulty construction, excessive pressure or other cause.

Blow-over. The excess of glass in making blown objects, projecting beyond the mold and afterward broken off. (Standard)

Blowpipe. A tube through which air is forced into a flame, to direct it and increase its intensity. In the compound blowpipe, two jets of gas (one of which may be air) are united at the point of combustion. (Raymond)

Blowpipe reaction. A decomposition of a compound when heated before the blowpipe, resulting in some characteristic reaction, as a coloring of the flame or a colored crust on a piece of charcoal (Standard). A useful method of analysis in mineralogy.

Blows (Leic.). Frequent and sudden risings of quicksand in sinking through water-bearing ground. (Gresley)

Blowtorch. A small automatic blast lamp or torch. (Webster)

Blowtube. A long wrought-iron tube, on the end of which the workman gathers a quantity of molten glass, and through which he blows to expand or shape it. (Webster)

Blowup. 1. (Eng.) An explosion of fire damp in a mine. 2. To allow atmospheric air access to certain places in coal mines, so as to generate heat, and ultimately to cause gob fires. (Gresley)

Blow wells (Eng.). A local term for Artesian wells, in the eastern coast of Lincolnshire, so called because the water often rushes up violently.

Blue. An assayer's term for a solution of copper sulphate. (Ricketts)

Blue asbestos. *See* Crocidolite.

Blue band. A bluish band of slate from one to four inches thick occurring 18 to 24 inches from the bottom of the No. 6 coal seam in Illinois.

Blue-billy (Eng.). The residuum of cupreous pyrites after roasting with salt. (Raymond)

Blue bind. Same as Bind, 1.

Bluecap. The characteristic blue halo or tip, of the flame of a safety lamp when fire damp is present in the air (Barrowman). *See also* Cap, 2.

Blue carbonate of copper. Same as Azurite.

Blue earth; Blue ground. *See* Kimberlite.

Blue elvan (Corn.). A synonym for Greenstone.

Blue ground. 1. (So. Afr.) A miner's name for the decomposed peridotite or kimberlite that carries the diamonds in the South African mines. (Kemp.)
2. (So. Staff.) Strata of the coal measures, consisting principally of beds of hard clay or shale. *See* Bind; *also* Bluestone, 2. (Gresley)

Blue iron earth. *See* Vivianite.

Blue ironstone. A synonym for Crocidolite (Chester). Blue asbestos.

Bluejack. Blue vitriol; copper sulphate (Webster). *See also* Chalcanthite.

Blue-john. A beautiful fibrous or columnar variety of fluorspar found in Derbyshire, England. Used for making ornaments. (Webster)

Blue lead. (Pronounced like the verb to lead.) The bluish auriferous gravel and cement deposit found in the ancient river-channels of California. (Raymond)

Blue lead-ore. An old name for a compact variety of galenite of a bluish-gray color. (Chester)

Blue malachite. Same as Azurite. (Standard)

Blue metal. 1. A copper matte containing about 60 per cent copper. (Webster)
2. (No. of Eng.). *See* Bind, 1; *also* Bluestone, 2.

Blue ocher. Same as Vivianite.

Blue oil. 1. A mixture of heavy oils and paraffin, obtained in the distillation of ozocerite. (Webster)
2. The oil produced from the heavy oil and paraffin of the Scotish shales by cooling and pressing for separation of hard paraffin scale; it is refined and fractionated into lubricating oils. (Bacon)

Blue opal. A synonym for Lazulite. (Chester)

Blue peach (Corn.). A slate-blue, very fine grained tourmaline. (Raymond)

Blue powder. That portion of vaporized zinc which does not condense as a liquid, but passes directly to the solid state in finely divided bluish powder. (Ingalls, p. 205; Hofman, p. 500)

Blue print. A blue photograph. *See also* Cyanotype. (Webster)

Blue room. The first room in a bag house. (Hofman, p. 131)

Blue schorl. 1. The earliest name for octahedrite. (Chester)
2. Blue tourmaline.

Blue-sky law. A law enacted to provide for the regulation and supervision of investment companies, in order to protect the public against companies that do not intend to do a fair and honest business.

Blue spar. Lazulite; azure-spar. (Century)

Bluestone. 1. The commercial name for a dark bluish-gray feldspathic sandstone or arkose. The color is due to the presence of fine black and dark-green minerals, chiefly hornblende and chlorite. The rock is extensively quarried in New York. Its toughness, due to slight metamorphism, and the ease with which it may be split into thin slabs especially adapt it for use as flagstone. The term has been locally applied to other rocks, among which are dark-blue slate and blue limestone. (U. S. Geol. Surv.)
2. (So. Wales). Hard clay or shale. *See also* Bind. (Gresley)
3. Copper-vitrol; copper-sulphate. (Raymond)

Blue talc. A synonym for Cyanite. (Chester)

Blue verditer. *See* Verditer, 2 and 3.

Blue vitrol. Copper sulphate; chalcanthite. Also called Copper vitriol.

Bluff. 1. A high bank, presenting a precipitous front to the sea or a river. 2. Blunt. 3. A fictitious show of strength. (Webster)
4. Altered country rock filling a lode. Analogous to mullock of Australia. (Halse)

Bluft (Leic.). To extinguish, or put out of sight, a candle or other light. (Gresley)

Bluing, or Blueing. The act or operation of giving a blue tint to iron or steel, as by heating, by the use of solutions, or by a combination of both processes; also, the tint so given. (Standard)

Blunge. In ceramics, to mix (clay) with water by means of a blunger or in a pug mill. (Standard)

Blunger. A wooden implement shaped like a spatula, but larger than a shovel, used in mixing clay with water. (Standard)

Bluntin (Derb.). A dark tough vein filling which dulls the drills readily. (Hooson)

Boam (Scot.). *See* Boom, 1.

Board. *See* Bord.

Board-and-pillar. Same as Pillar-and-breast.

Board-and-wall. Same as Bord-and-pillar, and Pillar-and-breast.

Board coal (Eng.). Coal having a fibrous or woody appearance. (Gresley)

Board run. The amount of undercutting that can be done at one setting of a coal-mining machine, usually about 5 feet, without moving for-

ward the board upon which the machine works. (Consolidated Coal Co. *v.* Gruber, 188 Illinois, p. 589)

Boart. Same as bort. (Century)

Boasting. The rough dressing of stone with a boasting chisel. (Standard)

Boasting-chisel. A flat chisel with an edge 2 inches wide, used in dressing stone. (Standard)

Boat. A gold dredge.

Boat coal (Penn.). Coal which is loaded into boats on canals, rivers, etc. (Gresley)

Boat level (Wales). A navigable adit. (Raymond)

Bob; Balance bob; Pump bob; Rocking bob. 1. A triangular or four-sided frame of heavy timber or of iron by which the horizontal motion communicated by the engine (connecting rod) is altered to the inclined or vertical motion of pump rods or of a man-engine (Chance). Used in connection with a Cornish pump.

Bobbin. 1. (Aust.) A catch placed between the rails of the up-line of an incline to stop any runaway trucks. It consists of a bent iron bar, pivoted in such a manner so that the down-hill end is slightly heavier than the up-hill end, which is capable of being depressed by an up-coming truck, but rises above the level of the truck axle as soon as the truck is past (Power). Also called Monkey-chock.
2. A spool or reel. (Webster)

Bobbing John (Scot.). An appliance formerly used in pumping, the motive power being water run into a box at the end of a beam working on a center, the pump rods being attached to the other end. (Barrowman)

Bob-pit. An excavation in which the balance box, attached to the pump-rods, works. (Duryee)

Boca (Mex.). Mouth of mine or tunnel, especially the place generally used as an entrance; head of a stull or post; heavy horizontal brace; *B. de barrena*, the bit of a drill. (Dwight)

Bocarte (Mex.). A stamp battery. (Dwight)

Bocartear (Sp.). To crush, stamp or grind ore. (Halse)

Bocazo (Sp.). A blown-out shot. (Halse)

Bocca. 1. The round hole in a glass furnace by which the fused glass is taken out. (Duryee)
2. A volcanic crater or vent. (Standard)

Boccarella (It.). A small mouth in a glass furnace on either side of the *bocca;* a nose hole. (Standard)

Bochorno (Mex.). Excessive heat with lack of ventilation. (Dwight)

Bodies seven. In alchemy, the metals corresponding to the planets, being gold, silver, iron, quicksilver, lead, tin, and copper, answering respectively to the sun, the moon, Mars, Mercury, Saturn, Jupiter, and Venus. (Standard)

Body. 1. A kind or form of matter; a material substance. (Webster) 2. An orebody, or pocket of mineral deposit. 3. The thickness of a lubricating oil or other liquid; also the measure of that thickness expressed in the number of seconds in which a given quantity of the oil at a given temperature flows through an aperture. (C. and M. M. P.)

Body of coal. A term frequently used to indicate the "fatty," inflammable property in coal, which is the basis of the phenomenon called combustion. (Nicolls)

Boetius furnace. An early gas-fired Belgian furnace with Boetius regenerators. (Ingalls, p. 448)

Boetius producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 304.)

Bog (Celtic for soft). A wet spongy morass, chiefly composed of decayed vegetal matter. (Power)

Bogar (Chile). In metallurgy, to skim. (Halse)

Bog butter. A fatty substance similar to adipocire found in the peat bogs of Ireland (Webster). *See also* Butyrellite.

Bog earth. A soil composed for the most part of the fine siliceous matter and partially decomposed vegetal fiber. (Webster)

Boghead cannel. *See* Torbanite.

Boghead coal (Scot.). A dark brown variety of cannel coal valuable as a source of paraffin oils and gas (Webster). *See also* Torbanite.

Boghead mineral. *See* Boghead coal; Torbanite.

Bogie; Bogey; Bogy. 1. (York.) A small truck or trolley upon which a bucket is carried from the shaft to the spoil bank. 2. A weighted truck run foremost or next to the rope in a train or trip. (Gresley)

Bogie engine. A switching engine, the running gear and driving gear of which are on a bogie or truck. (Webster)

Bog iron ore. A spongy variety of hydrated oxide of iron or limonite. Found in layers and lumps on level sandy soils which have been covered with swamp or bog (Roy. Com.). *See also* Brown iron ore.

Bog lime. A white powdery, calcareous deposit, precipitated through plant action on the bottom of many ponds and used in Portland cement manufacture. It is often erroneously called marl, a term which properly belongs to a calcareous clay. (Watson)

Bog manganese. A synonym for Wad.

Bog ore. 1. An iron hydroxide ore, as limonite, from marshy places. 2. Bog manganese. (Standard)

Bogwood (Eng.). The trunks and larger branches of trees dug up from peat bogs. (Page)

Bohemian garnet. *See* Pyrope.

Bohemian glass. An ornamental glass from Bohemia, noted for its rich colors and incised or engraved patterns. (Webster)

Bohemian ruby. A jeweler's name for rose quartz when cut as a gem. (Chester)

Bohemian topaz. A jeweler's name for yellow quartz when cut as a gem. (Chester)

Boil. The sudden generation of steam when molten iron runs over a cold or damp spot or object in runner. It often causes an explosion, whereby molten iron is scattered about. (Willcox)

Boiler. A closed vessel, usually cylindrical, used in generating steam, as for motive power; ordinarily made of riveted iron or steel plates, arranged to give an enlarged heating surface, with a space below for the fire, and often with internal flues for the smoke, etc. (Standard)

Boiler iron. Rolled sheet iron, such as is used in making steam boilers, varying in thickness from a quarter to half an inch, and in tensile strength from 40,000 pounds per square inch upward. (Standard)

Boiler scaler. A man who cleans scales from boiler tubing. (Willcox)

Boiler tube. One of the tubes by which heat from the furnace is diffused through the water in a steam boiler. (Nat. Tube Co.)

Boilery; Boilary. In law, water proceeding from a salt well belonging to one not the owner of the land. (Standard)

Boiling. 1. Heated to the point of bubbling; heaving with bubbles. 2. In metallurgy, *See* Puddling. (Webster)

Boiling furnace. A water-jacket reverberatory furnace for decarbonizing iron by a process in which the carbonic oxide escapes with an appearance of boiling. (Standard)

Boiling heat. *See* Boiling point.

Boiling point. 1. The temperature at which a liquid begins to boil, or to be converted into vapor by bubbles forming within its mass. It varies with the pressure. In water, under ordinary conditions, it is 212° F. or 100° C., but it becomes less with lessened atmospheric pressure, as in ascending a mountain being lowered about 1° F. for every 550 feet of ascent. (Standard)
2. The temperature at which crude oil on being heated begins to give forth its different distillates. The boiling point of crude oils and the amounts of distillates obtained at specified temperatures differ considerably. (Mitzakis)

Boiling spring. A spring or fountain which gives out water at the boiling point, or at a high temperature. (Century)

Boina (Mex.). A miner's cap. (Dwight)

Bojite. A name given by E. Weinschenk to a variety of gabbro, which occurs in association with the graphite of northern Bavaria. It differs from normal gabbro in containing hornblende, in addition to augite, and the name is intended to indicate a group of hornblendic gabbros just as norite implies those with hypersthene. The original bojite contained brown hornblende, colorless pyroxene, and reddish brown biotite. (Kemp)

Boke. 1. (Derb.). A small stringer of ore which soon dwindles out. (Hooson)
2. Derb.). A break or split in a vein. (Mander)

Bola (Sp.). A ball; *B. de grasa*, a slag-ball. (Halse)

Bolas. 1. (Mex.). More or less rounded masses of silver-gold ore. 2. (Sp.). Fine mercury ore molded into bricks. 3. Spherulites. 4. Balls of clay used in tamping. (Halse)

Bolderberg beds (Belg.). The sands and gravels of the Bolderberg hill, representatives of the Middle or Eocene Tertiaries, and often referred to by geologists. (Page)

Bole. 1. (Derb.). An old lead works. A place on high ground and exposed to the wind, where smelting has been carried on. (Hunt)
2. A friable earthy clay highly colored by iron oxide. 3. An old Scotch measure of about 4 bushels. *See also* Boll. (Webster)

Boleite. A deep blue pseudo-isometric hydrous oxychloride of lead, copper, and silver from Boleo, Lower California. A tetragonal form of percylite. (Dana)

Boleo (Mex.). 1. A dump for waste rock. 2. Float-miner. 3. A kidney of ore. (Dwight)

Boleta (Sp.). 1. A schedule. 2. A ticket for the sale of ore. 3. A voucher. 4. A tax receipt. (Halse)

Bolichar (Mex.). To treat ore in a *bimbalete*. (Halse)

Boliche. 1. (Peru). A dolly-tub. 2. (Mex.). A small ore mill like a *bimbalete*. (Dwight)
3. In Spain, a small reverberatory furnace for smelting lead ores. (Halse)

Bolivar (Venezuela). A silver coin equal to 1 franc, 9½d., or 19.8 cents. (Lock)

Boll. 1. (No. of Eng.). An ancient measure for coal, containing 9676.8 cubic inches. (Gresley)
2. *See* Bole, 3.

Bollito (It.). The frit or calcined ingredients from which glass is made. (Standard)

Bollo (Peru). 1. A pocket of ore. 2. A triangular block of amalgam. (Dwight)

Bologna spar. *See* Bolognian stone.

Bolognian stone. A sulphate of barium occurring in roundish masses and which is phosphorescent after calcination (Ure.) Also called Bologna stone, Bologna spar.

Bolsa (Peru). A rich body of ore; literally a purse. (Pfordte)

Bolsada (Sp.). A rich pocket of ore. In a general sense, an irregular deposit. (Halse)

Bolsilla (Sp.). A small pocket of ore. (Halse)

Bolsón. 1. (Sp.). A flat-floored desert valley that drains to a central evaporation pan or *playa*. (Ransome)
2. (Mex.). A pocket of ore. (Dwight)

Bolsonada (Peru). A pockety vein. (Dwight)

Bolt. 1. A nearly horizontal cylinder or prismoidal frame, usually, rotating, covered with silk or other fabric with very regular meshes, for sifting and separating flour of wheat from the hull or bran. Usually different sections of its length are covered with gradually decreasing sizes of mesh. Used in the talc and fuller's earth industries, etc. 2. To sift or separate by passing through a bolt. (Standard)
3. (So. Staff.). A short, narrow heading, connecting two others. Also called Bolt hole. (Gresley)
4. In glass-blowing, a cylindrical mass; as a bolt of melted glass. (Standard)

Bolt hole (So. Staff.). A short narrow opening made to connect the main workings with the air head or ventilating drift of a coal mine (Century). Also called Bolt.

Bolt oil. A viscous neutral oil having a gravity of 30° Bé. and a Saybolt viscosity of 220. Used in cutting nut and bolt threads. (Bacon)

Boltonite. A colored variety of forsterite, Mg_2SiO_4, crystallizing in the orthorhombic system. (Dana)

Bomb. 1. In geology, a more or less rounded mass of lava, anywhere from a few inches to several feet in diameter, generally vesicular, at least inside, thrown from the throat of a volcano during an explosive eruption. (La Forge)
2. The combustion chamber of a calorimeter fitted for use in making explosive combustions. 3. A missile containing an explosive, as dynamite. (Webster)

Bomba (Sp.). 1. A pump. 2. (Venez.). A patch or pocket of ore. 3. A volcanic bomb. (Halse)

Bombear. 1. (Colom.) To bring a large volume of water to the channel or ground sluice. 2. To discharge a miner or peón. (Halse)

Bombiccite. A transparent, colorless mineral, found in lignite in Tuscany; it fuses at 75° C., volatilizes at a higher temperature, and is soluble in carbon disulphide, alcohol and ether. (Bacon)

Bombillo (Mex.). Cartridge (as of dynamite). (Dwight)

Bonanza (Sp.). Literally, fair weather. In miners' phrase, good luck, or a body of rich ore. A mine is in *bonanza* when it is profitably producing ore (Raymond). *Compare* Borrasca.

Bond. 1. (No. of Eng.) Agreement for hiring workmen. 2. (Forest of Dean.) A turn made by a winding engine. 3. (No. Staff.). A bed, band, or seam of ironstone. (Gresley)
4. The arrangement of blocks of stone or brickwork to form a firm structure by a judicious overlapping of each other so as to break joint. (C. and M. M. P.)
5. An electrical connection between any two consecutive rails of an electric railway using the rails as a part of the return circuit. 6. A unit of chemical attraction. *See* Valence.
7. To give or secure an option upon a mine or other property by a bond tying up the property until the option has expired. (Webster)
8. The material which holds or binds together the crystals which make up a sharpening stone or grinding wheel, more commonly spoken of in connection with artificial abrasives. (Pike)
9. A certificate of ownership in a definite portion of a debt due from a government, a city, a business corporation, or an individual. In its simplest form it is a promise to pay a stipulated sum on or after a given date, and to pay interest or dividends at a specified rate and at definite intervals. (E. B. Skinner, p. 127)

Bonder. In masonry, a stone or brick extending through a wall and binding it together; a binding-stone. Also called Bondstone. (Standard)

Bondminder; Rolleyman; Roadman (Eng.). A man in charge of the rolley way, or main gangway. (Redmayne)

Bondstone. Same as Bonder.

Bone; Bone coal; Bony. Slaty or argillaceous coal, or carbonaceous shale occurring in coal seams (Chance)

Bone ash. The white porous residue from calcined bones, composed chiefly of calcium phosphate, used for making cupels and for cleaning jewelry (Webster). Called also Bone earth.

Bone bed (Eng.). A term applied to several thin strata or layers, from their containing innumerable fragments of fossil bones, scales, teeth, coprolites, and other organic remains (Page). *See also* Fish bed.

Bone black. The black, carbonaceous substance into which bones are converted by calcination in closed vessels; also called Animal black or Charcoal. (Webster)

Bone breccia. A deposit of bones, earth, sand, etc. (Webster)

Bone coal. *See* Bone.

Bone earth (Eng.). The earthy or mineral part of bones, which consists chiefly of calcium phosphate. (Page)

Bone phosphate. The calcium phosphate obtained from bones; also, in commerce, applied to calcium phosphate obtained from phosphatic rocks, as of North Carolina. (Standard)

Bone porcelain. A ceramic ware having bone dust as one of its constituents. (Standard)

Bonete (Mex.). A hat used to catch very rich ore as it is picked down with a sharp bar. (Dwight)

Bongkal (Straits Set.). A gold weight equals 832.84 gr.; 20 bongkals equals 1 catty. (Lock)

Bongo (Colom.). A wooden box in which the sand from the mill is deposited for subsequent treatment. (Halse)

Boninite. A glassy phase of andesite with bronzite, augite, and a little olivine, from the Bonin Islands, Japan. (Kemp)

Bonito (Mex.). First-class silver ore, *i. e.*, assaying over 1,000 oz. per ton. (Dwight)

Bonnet. 1. A covering over a mine cage to shield it from objects falling down the shaft. (Raymond)
2. A cover for the gauze of a safety lamp. (Steel)

3. A cap-piece for an upright timber. (C. and M. M. P.)
4. (Corn.). The cover of the steam chest of an engine. (Crofutt)
5. *See* Bell mold. (Gresley)
6. (Scot.). Gas coal or shale overlying and worked along with a coal seam. 7. (Scot.). A portion of a coal seam left for a roof. (Barrowman)

Bonnet roller; Bonnet pulley; Bonnet sheaf (Eng.). *See* Hat roller.

Bonney (Corn.). An isolated body of ore (Raymond). *See also* Bonny.

Bonny; Bonney; Bunny (Corn.). A mass of ore adjacent to a vein, but not distinctly connected with it; a great collection of ore without any vein coming into or going from it. (Century)

Boat (Eng.). 1. The cage and winding rope with attachments. (Gresley)
2. (Derb.). A narrowing of a mineral vein. (Hooson)

Boatle (Mid.). A hoisting cage full of men. (Gresley)

Boay coal. *See* Bone.

Bobbey (Som.). A box holding 6 to 8 cwt. of coal in which waste rock is sent to the surface. (Gresley)

Book clay; Leaf clay. Clay deposited in thin leaf-like laminae. (Power)

Bookstone. *See* Bibliolite.

Book structure. A peculiar rock structure resulting from numerous parallel sheets of slate alternating with quartz. (Lindgren, p. 154)

Book tiles. Flat, hollow shapes, having two segmental edges and resembling a book in section. (Ries)

Boolies (No. of Eng.). A collier's term for brothers. (Gresley)

Boom. 1. A long spar or beam projecting from the lower end of the mast of a derrick, to support or guide the body to be lifted or swung. 2. To develop rapidly in resource and population. 3. To cause a rapid increase in favor or price, as to boom a stock. (Webster)

Boom ditch. 1. The ditch from the dam used in booming. 2. A slight channel cut down a declivity into which is let a sudden head of water to cut to bed-rock and prospect from the apex of any underlying lode. (Miller)

Boomer. *See* Flop gate.

Booming. The accumulation and sudden discharge of a quantity of water (in placer mining, where water is scarce). *See* Hushing (Raymond). In California the contrivances for collecting and discharging water are termed "self-shooters," an idea suggested by the sudden and violent manner in which the water makes its escape. (Hanks)

Boose (Derb.). Gangue rock mixed with ore. *See also* Bouse.

Booster. A small amount of high explosive attached to a detonator for the purpose of increasing the rate of detonation of a charge. (Bowles)

Booster-fan. An additional fan placed at some point in a mine to assist in the ventilation.

Boot. 1. A leather or tin joint connecting the blast-main with the tuyère or nozzle in a bloomery. (Raymond)
2. (Eng.) A short pipe of leather through which the water is drawn from a sump into a sinking pump. (Gresley)
3. The casing at the lower end of a bucket elevator into which the material to be elevated is fed.

Bootit (Derb.). A term used by miners for loss, as "last reckoning I *bootit* it thirty." (Hunt)

Boot-leg. *See* Gun.

Boracite. A borate and chloride of magnesium, $Mg_3Cl_2B_{14}O_{30}$, occurring in hard glassy crystals, and in softer white masses. It is strongly pyroelectric. (Webster)

Boratera (Chile). A borax deposit. (Halse)

Borax. A crystalline sodium biborate. $Na_2B_4O_7.10H_2O$. *See also* Tincal. (Dana)

Borax bead. A drop of borax, in blowpipe analysis, which, fused with a small quantity of a metallic oxide, will show the characteristic color of the element; as, a blue borax bead indicates the presence of cobalt. (Standard)

Borcher's process. An electrolytic method for refining silver. The anode consists of granulated alloys containing about 60 per cent pure silver. The cathode of sheet silver is suspended in a cell with perforated double walls on each side. The electrolyte is dilute nitric acid or a solution of nitrates, preferably copper nitrate. (Goesel)

Bord (Newc.). 1. A passage or breast, driven up the slope of the coal from the gangway, and hence across the grain of the coal (Raymond). A bord four or more yards wide is called a wide bord, and one less than four yards in width is called a narrow bord. Also spelled Board. 2. A lateral passage at the place where a shaft intersects a coal seam. (Standard)

Bord and pillar method. A system of mining in which the distinguishing feature is the winning of less than 50 per cent. of coal on the first working. It is more an extension of the development work than mining. The second working is similar in principle to top slicing. The remainder of the coal is won by a retreating system, the cover being caved after each unit has been worked. The term "bord and pillar" is not used to any great extent in American mining literature, but has a place in English literature (Young). Various names have been applied to this method as: Checkerboard system; Brown panel system; Following up the whole with the broken; Lancashire bord and pillar system; Modified room and pillar working; Narrow working; North Staffordshire method; Rearer method of working inclined seams; Rock-chute mining; Room system; Room system with caving; Warwickshire method of working contiguous seams; Wide or square work; and Pillar and breast.

Bord course (Aust.). A direction at right angles to the main cleat or facing, *i. e.*, the length of a bord. (Power)

Bordeta (Sp.). A small pillar in a mine. (Crofutt)

Bord gate (York.). A heading driven generally to the rise, out of which stalls are opened and worked. (Gresley)

Bordo (Mex.). 1. A pillar left to support vein-matter. 2. A block of ground ready for stoping. (Dwight)

Bord room. 1. A heading driven parallel to the natural joints. (Gresley)
2. The space excavated in driving a bord. The term is used in connection with the "ridding" of the fallen stone in old bords when driving roads across them in pillar working; thus, "riding across the old bord room." (C. and M. M. P.)
3. (Eng.). The width across an old bord. (Bainbridge)

Bords and longwork (York.). A system of working coal. First, the main levels are started on both sides of the shaft and carried toward the boundary. Second, the bord gates are worked in pairs to the rise and continued as far as the boundary, or to within a short distance of a range of upper levels and other bord gates. Lastly, the whole of the pillars and remaining coal are worked out downhill to within a few yards of the levels, and ultimately, all the coal between the levels is removed. (Gresley)

Bord ways course. The direction at right angles to the main cleavage planes. In some mining districts it is termed "on face." (C. and M. M. P.)

Bore. 1. To make a hole or perforation with a boring instrument; to cut a circular hole by the rotary motion of a tool, as to bore for water, oil, etc. 2. A hole made by boring. *See* Borehole. 3. A tidal flood which regularly or occasionally rushes with a roaring noise into certain rivers of peculiar configuration or location, in one or more waves which present a very abrupt front of considerable height, dangerous to shipping. Also a very high and rapid tidal flow. (Webster)
4. A borehole; also, a tunnel, especially during its construction. (Standard)

Borebit. A rock boring chisel. (Standard)

Borehole. A hole made with a drill, auger or other tools, for exploring strata in search of minerals, for water supply, for blasting purposes, for proving the position of old workings, faults, and letting off accumulations of gas or of water (Gresley). *See also* Oil well.

Bore-hole pump. A pump for use in a bored well. (Standard)

Bore meal (Eng.). Mud or fine cuttings from a borehole. (Gresley)

Borer. 1. An instrument for boring. (Webster)
2. (Eng.). A piece of round iron with a steel point, which is driven into the rock to make holes for the purpose of blasting (Hunt). *See also* Drill.

Bore-rod (Newc.). *See* Boring rod.

Borgnet furnace. A Belgian zinc distillation furnace with a single combustion chamber. (Ingalls, p. 432)

Boring. 1. The act or process of making a hole with a boring tool. 2. A hole so made. 3. Material removed by boring. (Standard)

Boring bar. A revolving or stationary bar carrying one or more cutters or drills for boring.

Boring bit (Derb.). A sharp piece of steel at the end of an auger stem or drill for cutting rock or other material (Min. Jour.). *See* Bit, 1 and 2.

Boring contract. An agreement entered into between a producer and a contractor for the sinking of oil or gas wells on a property. (Mitzakis)

Boring head. The cutting end of a boring tool, especially the cutter head of a diamond drill. (Webster)

Boring journal. A book which contains an accurate record of the progress of the boring work, day by day. It is usually kept by the drilling master (Mitzakis). *See also* Log, 3.

Boring master. A man in charge of a well-boring outfit.

Boring rod. A rod made up of segments, carrying at its lower end a tool for earth boring or rock drilling. (Webster)

Borneador (Sp.). A man who turns a drill. (Halse)

Bornear. (Sp.). To turn a drill. (Halse)

Bornita (Mex.). Bornite. (Dwight)

Bornite; Erubescite; Peacock copper ore. A sulphide of copper and iron, Cu_5FeS_4. Contains 62 per cent copper (U. S. Geol. Surv.). Called also Horseflesh ore.

Borolanite. A rare rock related to the nephelite-syenites from Borolan, Sutherlandshire, Scotland. It has a granitoid texture, and consists principally of orthoclase and the variety of garnet called melanite. Biotite, pyroxene, sodalite, titanite, apatite and magnetite are accessory minerals. (Kemp)

Boron. A nonmetallic element occurring only in combination. May be obtained with difficulty as an olive-green, brown or reddish amorphous mass from its oxide, or as octahedral crystals resembling the diamond in hardness and other properties by heating the amorphous boron with aluminum. Symbol, B; atomic weight, 11.0; Specific gravity, 2.45.

Boronatrocalcite. *See* Ulexite.

Borra (Mex.). 1. Vein-matter. 2. Lead-dross. 3. Barren vein-matter or rock; *B. de veta*, soft rotten rock; *B. en borra*, unproductive ground. (Dwight)

Borrasca (Sp.). In mining, barren rock or non-paying ore: opposed to bonanza. Also spelled *Borasco; Bourasque* (Standard). An unproductive mine.

Borrow pit. An excavation made by the removal of earth, rock, etc., for use in filling, as in railroad construction.

Borsella. An instrument for stretching or contracting glass in its manufacture. (Standard)

Bort. 1. An impure variety of diamond (also chips and dust), used only for cutting and polishing. 2. Carbonado or black diamonds. (Standard)

Bosado (Colom.). Alluvial gold. (Halse)

Bosh. 1. A trough in which bloomery tools (or, in copper smelting, hot ingots) are cooled. 2. The portion of a shaft furnace in which it widens from above the hearth up to its maximum diameter. (Raymond) 3. (Wales). A tank or tub out of which horses drink. (Gresley)

Bosh breakouts. Breakouts of the blast, gas, or coke through the bosh brickwork of an iron blast furnace. (Willcox)

Bosh jacket. A water jacket used for cooling the walls of a shaft furnace.

Bosh plates. A flat water-cooled casting extending from inside to outside face of furnace walls to keep them from being softened by heat. (Willcox)

Bosque (Mex.). A forest; a grove. (Dwight)

Boss. 1. A person in immediate charge of a piece of work, as mine foreman. 2. (Ark.). A coal mine employee not under the jurisdiction of the miner's union. (Steel) 3. A master workman or superintendent, a director or manager; a political dictator. 4. A domelike mass of igneous rock congealed beneath the surface and laid bare by erosion. 5. The enlarged part of a shaft on which a wheel is keyed, or at the end where it is coupled to another. 6. A cast-iron plate

secured to the back of a traveling forge hearth. 7. A swage or die for shaping metals. (Webster)
8. A heavy cylindrical piece of iron (usually cast or steel) into the top of which the stamp stem fits and into the bottom of which the shoe is inserted. It is the body of the hammer into which the handle fits and which also gives heft to the blow. Also called Top head. (Rickard)
9. (Scot.). Hollow. The waste or exhausted workings of any mineral. To hole or undercut. (Barrowman)
10. A cushion or pad, as of soft leather or silk, used for smoothing or making uniform the colors applied with oil in porcelain and glass making. (Webster)

Boss driver. One in charge of men or boys who are driving horses or mules for hauling coal, rock, or ore at mines.

Bossing. 1. (Scot.). The holing or undercutting of a thick seam, as of limestone, the height of the undercutting being sufficient for a man to work in. (Barrowman)
2. In ceramics, the process of making a coat of color uniform, by dusting the color on boiled oil, or applying it plentifully mixed with oil, and tapping to smoothness with a boss or pad; ground-laying. *See* Boss, 10. 3. A coating of oil to be employed as above. (Standard)

Boss miner. 1. A contract miner. 2. In Ohio, 1883, a mine boss. (Roy)

Boss process. A continuous pan-amalgamation process for silver extraction. (Liddell)

Bostonite. A rock occurring in dikes, and having the mineralogical and chemical composition of trachyte or porphyry, except that anorthoclase (and therefore soda) is abnormally abundant, and dark silicates are few or lacking. The name was suggested by its supposed presence near Boston, Mass., but Marblehead, 20 miles or more distant, is its nearest locality. It has been found around Lake Champlain and in the neighboring parts of Canada. (Kemp)

Bota (Mex.). 1. A bucket made of one or more ox skins, to take out water. (Dwight)
2. *B. chica*, a small leather bag; *B. grande*, a large leather bag, worked by horse whims, for hoisting water. (Min Jour.)

Botch. A worthless opal. (Power)

Bote (Mex.). 1. A boat. 2. A can. 3. An ore bucket. (Dwight)

Botryogen. A vitreous hyacinth-red, translucent, hydrous magnesium ferro-ferric sulphate, crystallizing in the monoclinic system. (Dana)

Botryoidal. Having the form of a bunch of grapes (Webster). Said usually of minerals.

Botryolite. A radiated, columnar datolite with a botryoidal surface. (Standard)

Bott. 1. A plug of clay at the end of a bar, to stop the flow of melted metal from a cupola. (Standard)
2. A cast-iron or forged-steel plug mounted on long steel rod that fits inside of the cinder tap (Willcox). A blast furnace term.

Botting. Thrusting a bot into the tap hole to stop a run of slag or metal. (Willcox)

Bottle coal (Scot.). Gas coal. (Barrowman)

Bottle jack (Eng.). An appliance for raising heavy weights in a mine. (Gresley)

Bottle stone. An old name for chrysolite, or any other mineral, which can be melted directly into glass (Chester). *See also* Bouteillenstein.

Bottom. 1. The landing at the bottom of the shaft or slope. 2. The lowest point of mining operations. 3. The floor, bottom rock, or stratum underlying a coal bed. (McNeil)
4. Low land formed by alluvial deposits along a river. 5. (Aust.). The dry bed of a river of Tertiary age, containing alluvial gold, often covered to a great depth by volcanic matter or detritus. Also called Gutter. 6. To underrun with a level for drainage, etc., as a gold deposit which is to be worked by the hydraulic method. (Webster)
7. To break the material and throw it clear from the bottom or toe of the bore hole. (Du Pont)
8. A mass of impure copper formed below the matte, in matting copper ores (Weed). *See also* Bottoms, 2.

Bottom board (Eng.). The bottom of a wagon or truck which is unfastened by knocking off a catch when the wagon is required to be discharged. (G. C. Greenwell)

Bottom break. Same as Floor break. (Bowles)

Bottom cager. A man at the bottom of a shaft in a mine to superintend the operation of the raising and lowering of the cage. (Illinois Third Vein Coal Co. v. Cioni, 215 Illinois, p. 583.) *See also* Cager.

Bottom canch. *See* Canch, 2.

Bottom coal. Coal below the undercut. It may or may not be removed.

Bottom digger. A workman who digs out the bottom in an entry in thin coal, to give sufficient height for the haulage way.

Bottomer (Eng.). The man stationed at the bottom of a shaft in charge of the proper loading of cages, signals for hoisting of cages, etc. A cage or skip tender (Raymond). Also called Bottom cager.

Bottom filler. A man who fills a barrow with ore, coke, or stone, weighs it and places it on the cage, or elevator to be hoisted to top of the furnace. (Willcox)

Bottom ice. Ground ice; anchor ice. (Century)

Bottoming. 1. The ballasting material for making a roadbed; ballast. 2. The act of fitting with a bottom or performing some basal operation. (Standard)

Bottoming hole. The opening at the mouth of a furnace, before which a flint glass article, in process of manufacture, is exposed for softening. (Standard)

Bottom joint. A joint or bedding plane, horizontal or nearly so. (C. and M. M. P.)

Bottom lift. The deepest lift of a mining pump, or the lowest pump. (Raymond)

Bottom lifter. One who digs up the bottom of a drift, entry, or other haulage way to gain head room; also called Brusher; Dirt scratcher; Groundman; Ripper, and Stoneman.

Bottom pillars. Large blocks of solid coal left unworked around the shaft. *See also* Shaft pillar. (Gresley)

Bottom plate. A plate supporting a mold. (Webster)

Bottoms. 1. (Corn.) The deepest mine workings. 2. In copper smelting, the impure metallic copper, or cupriferous alloy, which separates from the matte, and is found below it, when there is not enough sulphur present to retain in combination all the copper. (Raymond)

Bottom-set beds. The layers of finer material carried out and deposited on the bottom of the sea or a lake in front of a delta. As the delta grows forward they are covered by the fore-set beds (La Forge). *See* Fore-set beds and Top-set beds.

Bottom settlings. Earthy matter, inert organic matter, or, in the case of Pennsylvania petroleum, an emulsion of amorphous paraffin wax and water, which accompanies crude oil. (Bacon)

Bottom stewards (York). Underground mine officials. (Gresley)

Bottom stone. *See* Fire clay.

Bottom water. In oil wells, water that lies below the productive sand, and is separated from it. *Compare* Top water; Edge water. (U. S. Geol. Surv. Bull. 658, p. 44.)

Boucharde (Fr.). A marble-workers' tool with which the surface of marble may be roughened or furrowed. (Standard)

Bougard marble. A dark-gray and white mottled stone with streaks and clouds of yellow, brown, and pink; from Nassau, Germany. (Merrill)

Bouking (Scot.). 1. Segments of wood or other material used for increasing the diameter of a drum. 2. To coil unevenly on a drum, as the rope or cable is not *bouking* well. (Barrowman)

Boulangerite. A massive metallic, bluish-gray lead-sulphur-antimony mineral, $Pb_5Sb_4S_{11}$. (Dana)

Boulder. *See* Bowlder.

Boulet (Fr.). A briquet.

Bouleur (Belg.). A small girl who collects coal into heaps in the working places underground. (Gresley)

Bounce. 1. A sudden spalling off of the sides of ribs and pillars due to excessive pressure; a bump. (C. M. P.)
2. An explosion, or the noise of one. (Webster)

Bound (Corn.). An area taken up for tin mining; a tin-bound. (Standard)

Boundary. 1. A line between areas of the earth's surface occupied by rocks or formations of different type and age; especially used in connection with geologic mapping, hence, also, a line between two formations or car-

tographic units on a geologic map. (La Forge)
2. That which indicates or fixes a limit or extent or marks a bound, as of territory. (Webster)

Boundary pillar. A pillar left between adjoining properties in mines. (Roy)

Bounder. 1. (Corn.) The owner of a small patch of ground called a "bound." (Davies)
2. One who, in early times, yearly fixed or marked the bounds of tin mines in Cornwall. (Standard)

Bournonite. A sulphide of lead, antimony, and copper. Approximately $PbCuSbS_3$. Sometimes called Wheel ore. (Dana)

Bourse. The Stock Exchange of Paris or other cities of Continental Europe. (Webster)

Bouse (No. of Eng.). Ore mixed with veinstone; second-class ore, which must undergo further preparation before going to the smelter. Also spelled Boose. (Century)

Bouse-team (No. of Eng.). The place where bouse is deposited outside of a mine, ready to be dressed or prepared for the smelter. (Century)

Bout. 1. (Mid.) A coil of rope upon a drum. 2. (Leic.) A dinner or other jollification given by the owners or lessees of a colliery to their workmen in honor of some special event (Gresley). Also called Do.
3. (Derb.) A measure of lead ore; twenty-four dishes. (Raymond)

Bouteillenstein; Bottlestone. A peculiar green and very pure glass, found as rolled pebbles near Moldau, Bohemia. It is also called Moldavite and Pseudochrysolite, the latter from its resemblance to olivine. It is not certainly a rock, as it may be prehistoric slag or glass. (Kemp)

Boutgate. 1. (Scot.). A road by which the miners can reach the surface. 2. A passage around a shaft at a landing. 3. A traveling road from one seam to another. (Barrowman)

Bouton (Scot.). 1. A mass of roof consisting of stone or shale. (Gresley)
2. (Scot.). A projecting stone in a shaft or underground road. (Barrowman)

Bóveda (Sp.) 1. A flue leading to stack. 2. An arch of a furnace. (Dwight)
3. A cave or cavern. 4. A chamber deposit. (Halse)

Bovedones (Peru). Large vaulted stopes or caves. (Dwight)

Bovey coal. A kind of brown coal (of the Miocene period) burning with a weak flame and generally a disagreeable odor. Found at Bovey, England. (Webster)

Bow. 1. A short, stout, bowed piece of wood with a cutting wire stretched between its ends: used in working clay in brick making. (Standard)
2. (Eng.). The bent iron bar or handle of a mine bucket. (Gresley)

Bowenite. An unusually hard massive, apple green or greenish-white variety of serpentine. (Dana)

Bower-Barff process. A process for producing, upon articles of iron or steel, an adherent coating of the magnetic oxide of iron, which is not liable to corrosion. (Webster)

Bowk (So. Staff.) 1. A small wooden box in which iron ore is hauled underground. (Raymond)
2. (Aust.) An iron bucket used for raising rock, etc., while sinking. (Power)
3. A report made by the cracking of the strata owing to the extraction of the coal beneath. *See also* Thud.
4. The noise made by the escape of gas under pressure. (G. C. Greenwall)

Bowlder, or Boulder. A fragment of rock brought by natural means from a distance (though this notion of transportation from a distance is not always, in later usage, involved) and usually large and rounded in shape. Cobble stones taken from river-beds are, in some American localities, called bowlders. (Raymond)

Bowlder-belt. A belt of glacial bowlders of many kinds, derived from distant sources and lying transverse to the direction of glacial movement. (Standard)

Bowlder-clay. The stiff, hard, and usually unstratified clay of the drift or glacial period, which contains bowlders scattered through it; also called Till, Hardpan, Drift-clay, or simply Drift (Roy. Com.). *See also* Till.

Bowlder-cracker. A heavy iron rod to be dropped upon a rock encountered by the drill in a deep well boring. (Standard)

Bowlder-fan. A series of bowlder-trains whose lines of direction are divergent. (Standard)

Bowldering-stone. Smooth translucent flint pebbles, found in gravel-pits and used to smooth the faces of emery wheels and glazers by abrading any large grains of emery or other powder on their surfaces. (Century)

Bowlder motion (Local, U. S.). A surface quarry worked only in detached masses of rock overlying the solid rock: sometimes contracted to Motion. (Standard)

Bowlder-pavement. A zone of bowlders, naturally arranged along a beach, and derived from contiguous beds of bowlder-clay. (Standard)

Bowlder pop. An alarm given when a bowlder is to be broken up by a pop shot. (Batesell v. American, Zinc, Lead, etc. Co., 190 Missouri App., p. 236)

Bowlder quarry. A quarry in which the joints are numerous and irregular, so that the stone is naturally broken up into comparatively small blocks (Ries). In Tennessee a local term applied to certain marble quarries in the region of Knoxville, where erosion has formed many large cavities and cracks, between which the rock stands up as pinnacles. The cavities are now filled with clay. (Bowles)

Bowlder-train. A train or line of glacial bowlders of the same sort of rock, extending from the source or parent ledge, perhaps for many miles, in the direction of the ice movement. (La Forge)

Bowl metal. The impure antimony obtained from doubling. *See* Doubling, 1. (C. and M. M. P.)

Bowse; Bouse; Bouze (Derb.). Lead ore as cut from the lode. (Raymond)

Box. 1. The part of a wheel which fits the axle. 2. The threaded nut for the screw of a mounted auger drill. More commonly called boxing. (Steel)
3. A flask or frame for sand molding. (Webster)
4. (Eng.). A vehicle in which coal is conveyed from the working places along the underground roadways and up the shaft. A hutch. (Gresley)

Box barrow. A large wheelbarrow with upright sides. (Webster)

Box-bill. A tool used in deep boring for slipping over and recovering broken rods. (Raymond)

Box bottoms (Leic.). The small coal or slack produced by breakage in transit underground, and by sorting at the surface. (Gresley)

Box canyon. A canyon, from the bottom of which four almost vertical walls appear on all four sides as a result of the canyon's zigzag course.

Boxed-off. Inclosed or protected by a wooden pipe or partition. (Gresley)

Boxes (Penn.). Wooden partitions for conducting the ventilation from place to place. (Gresley)

Box-groove. A closed groove between two rolls, formed by a collar on one roll, fitting between collars on another. (Raymond)

Box hardening. A process of case hardening by cementation in an iron box. (Webster)

Boxing. A method of securing shafts solely by slabs and wooden pegs. (C. and M. M. P.)

Box metal. A brass, bronze, or anti-friction alloy used for the journal boxes of axles or shafting. (Century)

Box timbering. Same as Plank timbering. (Raymond)

Bóya (Peru). A rich vein or pocket of ore. (Dwight)

Brace. 1. (Corn.) The mouth of a shaft. (Webster)
2. The platform, collar, or landing at the mouth of a shaft. (Roy. Com.)
3. A rigid piece, as of timber, to hold something, as parts of a frame, firmly in place. Especially, a framed diagonal piece in an angle; a strut. (Standard)
4. (Scot.). An old measure of weight. The Hurlet brace was equal to 4 cwt. (Barrowman)

Brace head. A cross-attachment at the top of the column of rods in deep boring, by means of which the rods and bit are turned after each drop. (Raymond). Same as Topit.

Brace key. Same as Brace head.

Brachy axis. The shorter lateral axis in the crystals of the orthorhombic and triclinic systems. (Webster)

Brachydiagonal. In crystallography, 1. Of or pertaining to the shorter lateral axis. 2. The shorter lateral axis. *See* Brachy axis. (Standard)

Brachydome. In crystallography, a dome parallel to the brachydiagonal. (Standard)

Brachypinacoid. A pinacoid parallel to the vertical and brachydiagonal axes. (Standard)

Brachypyramid. A pyramid whose intercept on the brachydiagonal is less than unity. (Standard)

Brachytypous. In crystallography, comparatively short. (Standard)

Bracket. A platform over a shaft entrance. (Standard)

Bradenhead. In oil-well drilling, an iron or steel head screwed into the top of the casing. The inner pipe projects up through it and is packed with some pliable substance, preferably rubber. The bradenhead is used to confine gas between the tubing and casing, or between two strings of casing, and has an outlet through which gas may be piped away. More commonly called Stuffing-box casing-head.

Bradenhead gas. In oil wells, natural gas inclosed or confined by a bradenhead. It applies to all the gas that lies above the oil and through which the drill must go to reach the lower and more profitable oil sands.

Bradford preferential separation process. A flotation process for the treatment of mixed sulphides, in which is added certain mineral salts, such as thiosulphates, to the water used in the flotation cells. The addition of the salt causes the zinc sulphide to be "wetted" while the lead sulphide and pyrite float. The separation of the zinc mineral from the gangue is effected later. (Megraw)

Brae (Scot.). 1. A hillside, a slope, a bank, a hill.
2. An inclined roadway, more commonly used in the compound form, *e. g.*, pulley-brae, cuddy-brae. (Barrowman)
3. Wood imperfectly burned in a charcoal pit. (Webster)

Braguetilla (Peru). A smelting furnace; the simplest being merely a hole in the ground. (Dwight)

Braird (Scot.). To increase the height of the holing or undercutting. (Barrowman)

Brairding (Scot.). The height of holing or undercutting at front. (Barrowman)

Brait. A rough diamond. (Standard)

Braise. A variant of breeze. The dust of charcoal which accumulates around the furnaces of charcoal works; coal dust; coke dust. (Century)

Brake. 1. (Eng.) A stout wooden lever to which boring rods are attached. It is worked by one or more men. 2. (No. Staff.). To lower trams on dips by means of a wheel and rope. (Gresley)
3. Any device for retarding or stopping by friction, as a block, lever, or band, applied to the rim of a head or drum or the axle of a wheel. (Webster)

Brake beam. The beam that connects the brake blocks of opposite wheels. (Webster)

Brake block. That part of a brake holding the brake shoe, or the shoe itself. (Webster)

Brake hanger. A bar or link suspending brake beams. (Webster)

Brake horse power. The actual power given out by an engine or other motor calculated from (1) the force exerted on a frictic brake, (2) the effective radius of this force, and (3) the speed of the flywheel or brake wheel. (Webster)

Brakeman. 1. A man in charge of a brake or brakes, as on a railroad car or in a mine. (Standard)
2. (Eng.) The man in charge of a winding (hoisting) engine for a mine. Brakeman is usually used in the United States; brakesman is British usage (Webster). The man in charge of hoisting engines, especially in the United States, is usually called a hoisting engineer.

Brake power. *See* Brake horse power.

Brake shoe. That part of a brake which rubs against some part of the machine, or some object outside of the machine having a relative motion to the shoe, as a wheel or the ground.

Brake sieve. A jigger, operated by a hand lever. (Raymond)

Brakesman (Eng.). *See* Brakeman.

Brake staff (Eng.). *See* Brake, 1; *also* Breakstaff.

Brake wheel. 1. A hand wheel for operating a brake, as on a vehicle. 2. A wheel or pulley on which a friction brake acts. 3. A heavy wheel provided with cams for controlling the movement of a trip hammer. (Webster)

Branses. *See* Brasses, 1.

Branch. 1. (Som.) An underground road or heading driven in coal measures. 2. An underground roadway turned from a level, etc. (Gresley)
3. (Corn.). A small vein departing from the main lode, and in some cases returning. (Raymond)

Branchite. A hydrocarbon mineral from the brown coal of Mt. Vaso in Tuscany. (Bacon)

Branch rope (Aust.). *See* District rope.

Branders (Scot.). Furnace bars.

Brandrig (Derb.). An iron guide at the foot of a pump to make the chain enter and prevent wearing. (Hooson)

Brannerite. A complex black opaque titanate of uranium and other elements in which the weight of uranium exceeds that of titanium. Excepting pitchblende, it is the most radioactive opaque mineral known. It contains approximately 48.8 per cent uranium oxides, 39 per cent titanium oxide, 3.9 per cent yttria earths, 4.1 per cent thoria, and small quantities of several other oxides. From the placers of Stanley Basin, Idaho.
Named for Dr. J. C. Branner.

Brard's process. A method adopted by M. Brard to discover in a short time the relative resistance offered by different kinds of rock to the action of moisture and frost, and therefore to determine their durability with reference to exposure. (Page)

Brasea (Sp.). Brasque; a mixture of powdered charcoal and refractory earth, used as a furnace-bottom lining. (Halse)

Brash. 1. A mass of loose or broken fragments of rocks resulting from weathering or disintegration on the spot. 2. Brittle. (Century)

Brashy. Resembling, or the nature of brash or broken fragments; crumbly. (Webster)

Brasque (Fr.). A paste made by mixing powdered charcoal, coal, or coke with clay, molasses, tar, or other suitable substance. It is used for lining hearths, crucibles, etc. Also called Steep. (Webster)

Brasqued crucible. A crucible lined with charcoal or lampblack, and used for the reduction of oxides of metals to the metallic state. The crucible is prepared by ramming it full of lampblack or charcoal, and then excavating a portion of its contents and polishing the lining with a burnisher. (Jackson)

Brass. 1. An alloy of copper and zinc. (Raymond)
2. *See* Brasses, 1.

Brass balls. Nodular pyrite. (Power)

Brass binder (Corn.). A thin pyritous grit. (Power)

Brasses. 1. (Eng. and Wales). Pyrite (sulphide of iron) in coal. (Raymond)
2. Fittings of brass in bearing blocks, etc., for diminishing the friction of revolving journals that rest upon them. (C. and M. M. P.)

Brassfounder's ague. A form of chills and fever common among brass founders and others exposed to the fumes of zinc. (Standard)

Brass furnace. One of two kinds of furnaces for the making and founding of brass. (a) A reverberatory furnace for large quantities of the alloy. (b) A crucible furnace for small quantities. (Century)

Brassil; Brazil. 1. Iron pyrite. (Power)
2. Coal containing pyrite. (Standard)

Brass ore. An early name for aurichalcite (Chester). A basic carbonate of zinc and copper.

Brass powder. 1. A pulverized mixture of copper filings and ocher.
2. Pulverized brass filings. (Standard)

Brassy top (Aust.). The top part of the Greta coal seam, in which there are large quantities of sulphide of iron. (Power)

Brat (Eng. and Wales). A thin bed of coal mixed with pyrite, or with calcium carbonate. (Raymond)

Brattice. 1. A board or plank lining, or other partition, in any mine passage to confine the air and force it into the working places. Its object is to keep the intake air from finding its way by a short route into the return airway (Chance). Also written Brettice, Brettis, Brattish. Temporary brattices are often made of cloth. *See* Brattice cloth.
2. (Mid.). A built-up pillar of cordwood sometimes like a large chock (*which see*), and serving a similar purpose. (Gresley)
3. Planking to support a wall or roof.
4. To provide with a brattice for separation or support. Frequently called Brattice up. (Webster)

Brattice cloth. A heavy canvas, often covered with some water proofing material, for temporarily forcing the air into the face of a breast or heading; also used in place of doors on gangways; then known as "sheets." (Chance)

Brattice man. A person who assists the fire boss in constructing brattices. (Steel)

Brattice road. A road through the goaf supported by chocks or timber packs. (Gresley)

Brattice trick (Aust.). A trick played on inspectors when measuring the air in a mine, the quantity of air being reduced in some districts below its normal amount, in order to increase it in the district being tested. Usually effected by placing a piece of brattice cloth across one of the return airways. (Power)

Brattice wall. The bratticed side of an aircourse or roadway. (Gresley)

Bratticing; Brattishing. A partition in a mine to form an air passage. (Century)

Brattish. A variation of Brattice.

Braunite. A somewhat variable manganese silicate, approximately $3Mn_2O_3.MnSiO_3$. (U. S. Geol. Surv.)

Braze. To solder with hard solder which usually is copper and zinc—half and half. (Nat. Tube Co.)

Braze-jointed. United by a brazed joint or joints. (Webster)

Brazen dish (Eng.). The brass gage, or standard, used in the Low Peak district, Derbyshire, about 1.500. The miners formerly measured lead ore in this dish. It had a capacity of 8 quarts, and was chained at a certain public place. (Hunt)

Brazier. 1. An artificer who works in brass. 2. A pan for holding burning coals. (Webster)

Brazil; Brazzil. Pyrite. (Raymond)

Brazilian chrysolite. A jeweler's name for yellowish-green tourmaline, cut as a gem. (Chester)

Brazilian emerald. A green variety of tourmaline. (Power)

Brazilian pebble. A colorless transparent quartz, such as is used for optical purposes. (Chester)

Brazilian ruby. A light rose-red spinel; or a topaz approaching a red color. (Power)

Brazilian sapphire. A blue variety of tourmaline. (Power)

Brea. 1. Sand or soil impregnated with petroleum from seepages, the volatile constituents having evaporated. (Bacon)
2. Maltha or mineral tar. (Webster)

Breach. 1. An opening made by breaking down a portion of a solid body, as a wall, a dike, or a river bank; a break; a gap. (Century)
2. The face of a level or drift. (Skinner)

Break. 1. A fault; rupture, fracture. (Webster)
2. A crack or small natural cavity or fracture in a coal seam. 3. A crack, often several inches in width, proceeding from old workings or hollows. (Gresley)
4. To come apart or divide into two or more pieces, usually with suddenness and violence; to part. to burst asunder. (Webster)
5. (Scot.). A reduction of the day's wage. (Barrowman)

Break line. 1. The line in which the roof of a coal mine is expected to break. 2. The line of complete extraction of coal. 3. A line roughly following the rear edges of the pillars that are being drawn or mined.

Breakage clause (Eng.). A clause inserted in some mining leases providing for an abatement of royalty or allowance on weight for a certain weight of small coal or breakage sent out in every ton of large coal, *e. g.*, 120 lb. in every collier's ton of 2,640 lb. (Gresley)

Breakback. The fractures caused by the shattering of a solid rock ledge back of the drill holes in which the charge is placed. (Bowles)

Breaker. 1. In anthracite mining, the structure in which the coal is broken, sized, and cleaned for market. Known also as Coal breaker. (Chance)
2. A machine for breaking rocks or for breaking coal. (Webster)
3. (No. of Eng.) A large crack formed in the roof next to the goaf. *See* Break, 1. 4. (Som.) A coal miner or hewer. 5. (Italy) A collier who wedges down coal and fills it into cars. (Gresley)
6. A wave breaking into foam against the shore, or against a sand bank, or a rock or reef near the surface. 7. A transverse ridge in a road to facilitate drainage. (Webster)

Breaker boy. A boy who works in a coal breaker. *See* Breaker, 1. (Steel)

Breakes (Eng.). Fissures in old coal workings (Bainbridge). *See also* Break. 3.

Break-in (Som.). To commence to hole. (Gresley)

Breaking. 1. (Eng.) The breaking of poor or dradgy ore by hand with flat irons, called breaking hammers. (Hunt)
2. (Can.) The poor part of ore ready for crushing. (Morine)

Breaking band (Scot.). A method of setting or fixing props in the workings, in lines running diagonally to the line of the face or wall (Gresley). *Compare* Breaking prop.

Breaking-down machine (Eng.). A mechanical appliance, worked by compressed air, or by hydraulic power, for bringing down the coal after holing. (Gresley)

Breaking-down rolls. The first set of rolls through which hot iron is passed in a rolling mill (Standard). Called also Roughing rolls; Roughing-down rolls.

Breaking-in shot. The first bore hole fired in "blasting off the solid" to provide a space into which material from subsequent shots may be thrown (Du Pont). Also called Opening shot; Buster shot.

Breaking load. The steady and gradually applied load under which a material of construction will break asunder or collapse. (Webster)

Breaking prop (Ark.). One of a row of props of sufficient strength to cause the rock above the coal to break and so limit the area of top brought down by a brushing shot (Steel). *Compare* Breaking band.

Breaking strain; Breaking strength; Breaking stress. The least load that will break a rope. These terms are used indiscriminately to mean the load that will break a rope. The stress on a rope at the moment of breaking is the breaking stress, and the strain or deformation produced in the material by this stress is the breaking strain. (C. M. P.)

Breaking-up (Clev.). A system of employment under which a skilled miner engages an unskilled man, the former paying the latter a mere laborer's wage until he becomes an experienced miner. (Gresley)

Break in lode. A fault. (Duryee)

Breakoff. 1. (Eng.). A short narrow heading driven from one road to another; a breakthrough. (Gresley)
2. (Derb.). An alteration in the vein due to an intrusion of barren rock, or to a fault. (Hooson)

Breakout. Escape of gas, coke, slag, or iron from the bosh, tuyère, breast, or hearth of a blast furnace. (Willcox)

Breakstaff. The lever for blowing a blacksmith's bellows, or for working bore rods up and down (C. and M. M. P.)

Break-through. 1. A narrow passage cut through the pillar to allow the ventilating current to pass from one room to another. Also called a Crosscut, or Room crosscut. Larger than a dog hole. (Steel)
2. An opening accidentally made between two workings.

Break-up. 1. (Eng.). An excavation commenced from the bottom of a tunnel heading and carried upward, so as to form two interior working faces. (Simms)
2. (Mid.). To cut away and remove the floor of an entry or other opening. (Gresley)
3. The thawing and breaking of ice on a river or other body of water with the advent of spring.

Breakwater. A structure or contrivance, as a mole, mound, or wall, serving to break the force of waves and protect a harbor, or anything exposed to the force of the waves. (Century)

Breast. 1. The face of a working.
2. In coal mines, a chamber driven in the seam from the gangway, for the extraction of coal. 3. That side of the hearth of a shaft furnace which contains the metal notch. (Raymond)
4. (Italy). A stall in a steep seam from 12 to 18 yards wide. The stalls are carried one above another from the lowest level to the rise. 5. (Leic.). To take down or get a buttock (face) of coal end-on. (Gresley)
6. That part of the bedplate which is back of the crossheads in engines of the Corliss type. (Crofutt)

Breast-and-pillar (Penn.). A system of working anthracite coal by bords 10 yards in width, with narrow pillars 5 yards wide between them, holed through at certain intervals. *See* Bord-and-pillar. The breasts are worked from the dip to the rise. (Gresley)

Breast auger. An auger supported by a breast plate against the miner's body. Used for drilling holes in soft coal. (Steel)

Breast boards. Planking placed between the last set of timbers and the face of a gangway or heading which is in quicksand or loose ground. (Raymond)

Breast-bore (Scot.). A borehole put in parallel with the seam, made and kept in advance of a working-place, for the purpose of ascertaining the position of old works, tapping water, letting off gas, etc. (Gresley)

Breast-eyes (Lanc.). *See* Day, 1; Day eyes, *also* Day-hole.

Breast-heads. Natural joints in rock, coal, etc. (Gresley)

Breast holes. Relief holes used in tunneling, and which are fired after the bottom cut. (Du Pont)

Breasting. 1. (No. Staff.) A short leading stall, worked at right angles to and forming the face of the main levels. 2. A wide heading or level. (Gresley)
3. (Eng.) Taking ore from the face or head of a drift. (Skinner)

Breastplate. A slightly curved iron plate fastened to the end of a coal auger to enable the miner to press the auger forward with his body. (Steel)

Breast stoping. A method of stoping employed on veins where the dip is not sufficient for the broken ore to be removed by gravity. The ore remains close to the working-face and must be loaded into cars at that point (Crane). *See also* Overhand stoping.

Breast wall (Eng.). A wall built to prevent the falling of a vertical face cut into the natural soil. (C. and M. M. P.)

Breast wheel. A type of water wheel on which the water is led at about half the height of the wheel. The water acts partly by impulse and partly by weight as it descends in the buckets. (Webster)

Breather (Eng.). An apparatus enabling a man to enter and explore underground workings filled with noxious gases. (Gresley, 1883)

Breccia. A fragmental rock whose components are angular and therefore, as distinguished from conglomerates, are not water-worn. There are friction or fault breccias, talus-breccias and eruptive breccias. The word is of Italian origin. (Kemp)

Breccia marble. Any marble made up of angular fragments. (Merrill)

Brecciated. Converted into, or resembling, a breccia. (Webster)

Brecciated vein. A fissure filled with fragments of rock in the interstices of which vein matter is deposited. (Shamel, p. 146)

Brecha. 1. (Mex.) Breccia. 2. (Colom.) An open trench or cut leading to the mouth of an adit; or a channel by which pay gravel is led to the ground sluice. 3. (Port.) A prospecting cut. (Halse)

Breeching. 1. (Mid.) Drawing loaded trams down hill underground. (Gresley)
2. That part of a harness which passes round the breech of a horse, enabling him to hold back a vehicle.
3. The sheet-iron casing at the end of boilers to convey the smoke from the flues to the smokestack. (Webster)

Breeding-fire (So. Staff.). Spontaneous combustion in a mine. *See also* Gob fire. (Gresley)

Breese. *See* Breeze.

Breeze. 1. (Eng.) Small coke. Probably connected, perhaps interchangeable, with Braize, and both with the Fr. *Braise*, to cook over live coals. (Raymond)
2. (Scot.) Fine or slack coal. (Gresley)

Breeze oven. 1. An oven for the manufacture of small coke. 2. A furnace designed to consume breeze or coal dust. (Century)

Breithauptite. Nickel antimonide NiSb). *See also* Niccolite. (Dana)

Brelho (Port.). A pebble; a small stone. (Halse)

Bremen blue. *See* Verditer, 3.

Brenner (Eng). A smelter (Bainbridge). An old variant derived from the word burn. A burner.

Brenston. *See* Brimstone.

Brettice; Brettis. *See* Brattice.

Brettice cloth. *See* Brattice cloth.

Brettis (Derb.). A crib of timber filled up with slack or waste (Raymond). *See also* Brattice, 3.

Brettis-way (Derb.). A road in a coal mine, supported by brattices built on each side after the coal has been worked out (Raymond). *See also* Brattice, 3.

Breunnerite. A variety of magnesite containing several per cent of FeO. (Dana)

Brick. A building and paving material made from clay by molding into blocks while moist, and hardening it in the sun or by fire. (Webster)

Brick ax. A two-edged ax used for cutting off bricks. (Webster)

Brick clamp. A stack of bricks for burning, in layers alternating with layers of breeze, or fine coal and cinders. (Standard)

Brick clay. Any clay that can be used for brick manufacture. (Ries)

Brick coal (Eng.). Small, dirty coal suitable for brick kilns and similar purposes. (Gresley)

Brick earth. Clay or earth for making bricks. (Webster)

Brickfield; Brickyard. A field or yard where bricks are made. (Century)

Brick fuel (Wales). Patent fuel; a synonym for Briquet.

Bricking. The walling or casing of a shaft. (Gresley)

Brick kiln. 1. A structure of unburned brick built into flues and chambers through which heat passes from a fire below, burning the brick. 2. A permanent structure, having stacks or chimneys, in which unburned bricks are burned by heat from a central source. (Standard)
3. A pile of green bricks arched underneath to receive the fuel for burning them. (Webster)

Brick layer's itch. An itching eczema of the hands occurring among bricklayers, caused by contact with lime. (Webster)

Brick machine. An apparatus for molding bricks. (Century)

Brick red. A dark orange-red like that of common bricks. (Webster)

Brickstone (Prov. Eng.). A brick. (Century)

Brickyard. A place where bricks are made. (Standard)

Bridge. 1. A low separating wall, usually of fire brick, in a reverberatory furnace between the hearth and the grate (fire bridge) or sometimes between the hearth and the flue (flue bridge). Often called bridge wall. 2. A plank way or platform to convey fuel or ore to the mouth of a furnace. 3. A device to measure the resistance of a wire or other conductor forming a part of an electric circuit. (Webster)
4. A piece of timber held above the cap of a set by blocks and used to facilitate the driving of spiling in soft or running ground. (Sanders)
5. *See* Air crossing.
6. (Eng.). A platform mounted on wheels, for covering the mouth of a shaft when landing coal, rock, or men at surface. (Gresley)

Bridge operator. One who operates an ore bridge of the Gantry crane type. (Willcox)

Bridge rails (Aust.). Rails made in the form of an inverted U, generally in short lengths, which are light to handle, and can be brought within easy shoveling distance of the face. (Power)

Bridge wire. The fine platinum wire which is heated by the passage of an electric current to ignite the priming charge of an electric blasting cap, an electric squib or similar devices. (Du Pont)

Bridgman sampler. A mechanical device which automatically selects 2 samples as the ore passes through. (Hofman, p. 59)

Bridle bar. The transverse bar connecting the points of a tramway switch (C. M. P.). *See also* Bridle rod.

Bridle chains. Safety chains to support the cage if the shackle should break, or to protect a train of cars on a slope should the shackle or drawbar fail.

Bridle iron. A strong flat iron bar so bent as to support, as in a stirrup, one end of a floor timber, where no sufficient bearing can be had. (Webster)

Bridle rod. An iron tiebar used to join the ends of two switch rails to hold them to gage (Webster). A bridle bar.

Brier (No. of Eng.). A beam or girder fixed across a shaft top. (Gresley)

Briggs' standard. A list of pipe sizes, thickness, threads, etc., compiled by Robert Briggs about 1862 and subsequently adopted as a standard. (Nat. Tube Co.)

Brightening. *See* Blick.

Bright-head (York). A smooth parting or joint in coal. A plane of cleavage. (Gresley)

Bright rope. Rope of any construction, whose wires have not been galvanized, tinned, or otherwise coated. (C. M. P.)

Brilliant. A diamond of the finest cut, reflecting and refracting light by means of the faces and facets formed upon it. (Standard)

Brillo (Mex.). Luster. (Dwight)

Brimstone. A common name for sulphur.

Brine. Water strongly impregnated with salt. (Webster)

Brine pit. A salt spring or well from which water is taken to be boiled or evaporated for making salt. (Century)

Brine spring. A spring of salt water. (Century)

Bring-back (Eng.). To work away the pillars of coal from the boundary toward the shaft bottom. (Gresley)

Brin's process. A process for manufacturing oxygen, in which barium monoxide is converted into dioxide by heating in air, and the dioxide by further heating is decomposed into the monoxide and oxygen. (Webster)

Briolette (Fr.). An oval or pear-shaped diamond having its entire surface cut in triangular facets. (Webster)

Briquet. 1. Fuel consisting of slack, or coke breeze, with usually some binding material, and pressed into lump form; also called Coalette, Egette, Boulet, and Carbonet. (Steel)
2. An artificially compressed block, as of ore, coal dust, etc. (Standard)

Briquettes (Fr.). *See* Brick fuel; *also* Briquet.

Briscale (It.). A gypsiferous deposit occurring at the outcrop of the sulphur deposits of Sicily. (W. C. Phalen, mineral technologist, U. S. Bur. Mines.)

Bristol diamond. A fine transparent variety of crystallized quartz. Also called Irish diamond. (Power)

Bristol stone. 1. Brick-like blocks of very fine sand used for polishing and scouring. 2. Bristol diamonds, or small well-defined crystals of quartz from Bristol. (Standard)

Britannia. An alloy, made of tin with varying proportions of copper and antimony (Standard). Called also Britannia metal, and Tutania.

Britching (Scot.) *See* Breeching. 2.

British; Brettys (Scot.). A variation of Brattice.

British barilla. Same as Black ash. (Standard)

British plate. Albata, an alloy of nickel, copper, and zinc. (Standard)

British thermal unit. The $\frac{1}{180}$ quantity of heat required to raise the temperature of one pound of water from 32° to 212° F.; substantially equal to that required to raise the temperature of one pound of water from 63° to 64° F. (G. A. Goodenough, Mech. Eng. Handbook, 1916, p. 295) Abbreviated as B. t. u.

Brittle. Easily broken; not tough or tenacious. (Dana)

Brittle mica. A synonym for Margarite.

Brittle silver ore. A synonym for Stephanite.

Broach. 1. A sharp-pointed chisel for rough-dressing of stones. 2. A reamer. 3. To shape roughly, as a block of stone, by chiseling with a coarse tool. (Webster)

Broaching. Trimming or straightening a mine working. (Morrison)

Broaching-bit. A tool used to restore the dimensions of a bore hole which which has been contracted by the swelling of the marl or clay walls; also used to break down the intervening rock between two contiguous drill holes. A reamer.

Broadgate (Eng.). A main working. (Bainbridge)

Broadstone bind (Eng.). Shale or clay which breaks up into large blocks or slabs. (Gresley)

Broadwall (No. of Eng.). *See* Longwall.

Brob. 1. A heavy spike, driven alongside the end of an abutting timber to prevent its slipping. (Raymond)
2. (Mid.). A short thick timber prop or sprag for supporting the coal while it is being holed. (Gresley)

Broca (Mex.). A drill bit. (Dwight)

Brocal (Sp.). The first set of shaft timbers; the collar; *B. del tiro*, the mouth of a shaft; *B. del pozo*, a well curb, or mouth of a well. (Halse)

Brocar (Port.). To bore or drill. (Halse)

Brocatelle marble. A variety of marble from the French Pyrenees. The body of the stone is fine, compact and of light-yellow color traversed by veins and dull-red blotches. The name signifies a coarse kind of tapestry, which it somewhat resembles (Merrill). *See also* Broccatello, the Italian term.

Broccatello. An Italian word for a brecciated and variegated marble (Kemp). *See also* Brocatelle, the French term.

Brochantite. A basic sulphate of copper, $CuSO_4.3Cu(OH)_2$. (U. S. Geol. Surv.)

Bröggerite. A radioactive mineral provisionally classified as a variety of uraninite. It occurs in octahedral crystals. Sp. gr., 9.03. (Webster)

Broil (Corn.). A collection of loose rock fragments usually discolored by oxidation, and indicating the presence of a mineral vein beneath; outcrop; gossan (Century). Also spelled Bryle, Broyl.

Broken. 1. (Eng.). That part of a mine where the mineral has already been partly worked away, and where the remainder is in course of being extracted. (Gresley)
2. The dislocation of a vein by faulting. (Weed)

Broken ashlar. Ashlar in which the stones are rectangular, but of different sizes and shapes. (Webster)

Broken charge. A charge of explosive in a drill hole divided into two or more parts that are separated by stemming. (Bowles)

Broken coal. In anthracite only; coal that is small enough to pass through a 3⅜ to 4-inch (square) aperture, but too large to pass through a 2¾ or 2½-inch mesh. Smaller than steamboat, and larger than egg coal. (Chance)

Broken ground. 1. Rock strata where the walls are poorly defined and the general formation shattered. (Weed)
2. (Eng.). Faulty or unproductive measures. (Gresley)

Broken-range work. Masonry-work made of squared stones in courses of uneven heights. (Standard)

Broken skip (Aust.). A skip (car) from which some of the coal has fallen off in transit leaving only a part of a skip load. (Power)

Bromargyrite. *See* Bromyrite.

Bromine. One of the elements, which is at ordinary temperature, a deep reddish-brown caustic liquid of a very disagreeable odor. Symbol, Br: atomic weight. 79.92; specific gravity, 3.2. (Webster)
It does not occur native but is derived in large quantities from brines. Its form of occurrence in the brines is unknown. (U. S. Geol. Surv.)

Bromite. Same as Bromyrite.

Bromlite. A barium-calcium carbonate $(Ba,Ca)CO_3$ from Bromley Hill, Eng. Also called Alstonite. (Webster)

Bromyrite. A silver bromide, AgBr, containing 57 per cent. silver. (U. S. Geol. Surv.)

Bronce (Sp.). Iron or copper pyrites. Bronze. Any mineral like bronze or brass in appearance. (Halse)

Bronco (Mex.). Wild, loose. Roof-rock, liable to fall. (Dwight)

Brongniardite. A lead-silver sulphantimonide, $PbAg_2Sb_2S_4$. Contains 26.2 per cent. silver. (U. S. Geol. Surv.)

Bronquear (Mex.). To hammer or pry with hammer or gad in rock which is loose and liable to fall. (Dwight)

Brontolith. A meteoric stone; a thunder-stone. (Standard)

Bronze. An alloy of copper and tin. (Raymond)

Bronze-gold. Any bronze resembling gold in color. (Standard)

Bronze mica. A synonym for Phlogopite.

Bronze steel. An alloy of copper, tin, and iron: used as gun metal. (Standard)

Bronzite. 1. A ferriferous variety of enstatite often having a bronze-like luster. (Webster)
2. Is often used as a prefix to the names of rocks containing the mineral. Rocks of the gabbro family are the commonest ones that have the prefix. (Kemp)

Bronzitite. An igneous rock composed wholly of bronzite. (Standard)

Bronzudos (Mex.). Pyritic ores. (Halse)

Brooch (Corn). A mixture of various ores. (Power)

Broeching. *See* Broaching.

Brood (Corn.). The heavier kinds of waste in tin and copper ores (Raymond). A mixture of tin and copper ore. (Pryce)

Brookite. Titanium dioxide, TiO_2. Identical in composition with rutile, but occurs in brown translucent orthorhombic crystals. (Dana)

Broqueiro (Braz.). A miner, borer, or driller. (Halse)

Brora (Eng.). In Sutherland, the imperfect coal in the lower part of the Oölite formation. (Roberts)

Brosing; Brosing time (Scot.). Meal time. (Barrowman)

Brotazón de veta (Mex.). Apex of vein; croppings. (Dwight)

Brouse (Derb.). A sort of coarse stopping, made of small boughs of trees, and placed back of shaft timbers to prevent rock from falling. (Hooson)

Brow. 1. (Lanc.) An underground roadway leading to a working place, driven either to the rise or to the dip. 2. A low place in the roof of a mine, giving insufficient headroom. (Gresley)
3. The edge or projecting upper part of a steep place, as the brow of a precipice or hill. (Webster)

Brow bar (Mid.). A massive curb or beam of timber fixed in the wall of the shaft across the top of an inset or station (Gresley). Also called Brow piece.

Brown clay-ironstone. Compact, often nodular masses of limonite with clay impurities. (Moses)

Brown coal. Lignite. A fuel intermediate between peat and bituminous coal. (Steel)

Brown-face. Gossan of the tin lodes of Tasmania. (Vogt)

Brown hematite. Limonite. *See also* Brown iron ore.

Brown hen (Derb.). A hard, brown clay which sticks to the ore, making the ore look poor, to the disadvantage of the miner. (Hooson)

Brown horseshoe furnace. A furnace of the annular turret type for calcining sulphide ores. (Peters, p. 218; Hofman, p. 182; Ingalls, p. 85)

Brown iron ore; Limonite; Brown hematite; Bog iron ore. Its approximate formula is $2Fe_2O_3.3H_2O$, equivalent to about 59.8 per cent iron. Probably a mixture of hydrous iron oxides. (U. S. Geol. Surv.)

Brown lead ore. An early name for brown pyromorphite. (Chester)

Brown muffle furnace. A merchanically-raked roasting furnace of the straight-line type with a series of longitudinal combustion flues placed under the hearth. (Ingalls, p. 139)

Brown-O'Hara furnace. A long, horizontal, double-hearth furnace for the treatment of lead ores. (Hofman, p. 190)

Brown panel system. Same as Pillar-and-breast in coal mining.

Brown petroleum. A natural solid, or semi-solid product produced by the action of air upon fluid bitumens. (Bacon)

Brown spar. Any light carbonate, colored brown by the presence of iron oxide, as ankerite, dolomite, magnesite, or siderite. (Standard)

Brown stone (Aust.). Decomposed iron pyrite. (Power)

Brownstone. A dark-brown sandstone from quarries in the Triassic, especially from the Connecticut River valley. Used as a building stone (Century). *See also* Sandstone.

Brown tank. A cylindrical tank or vat, tall in proportion to its diameter, with the bottom ending in a 60° cone. Within the tank is a hollow column extending from the bottom to within about 8 inches from the top. The apparatus works on the air-lift principle, the aerated pulp in the tube flowing upward, and discharging at the top while more pulp flows in at the bottom to take its place. It is in reality a pulp agitator. Also called Pachuca tank.

Brown umber. A brown earthy variety of limonite. (Power)

Brow piece. A heavy timber used for underpinning in the opening of a station for a new level in a mine. (Webster). *See* Brow bar.

Browse. Ore imperfectly smelted, mixed with cinder and clay. (Raymond)

Brow-up (Lanc.). An inclined roadway driven to the rise. Also called Brow or Up-brow. (Gresley)

Broxburn oil shale. A Scottish shale which yields 23 to 35 gals. of crude oil and 35 to 40 lbs. of ammonium sulphate per ton. (Bacon)

Broyl (Corn.). *See* Broil.

Broza (Batopilas, Mex.). 1. Ore containing two-thirds native silver and one-third calcite. 2. (Chile) Waste, rubbish. (Halse)
3. (Peru) Very poor ores which generally do not repay extraction. (Dwight)

Brozires (Bol.). Men who break large stones in the mines. (Halse)

Brucite. Hydrated magnesium oxide, $MgO.H_2O$. (Dana)

Brückner cylinder (Pac.). A form of revolving roasting furnace (Raymond). *See* Brückner furnace.

Brückner furnace. A horizontal revolving, cylindrical furnace for roasting pulverized sulphide ores. (Peters, p. 196; Hofman, p. 198; Ingalls, p. 121)

Brújula (Mex.). Magnetic compass. (Dwight)

Brunnerite. A blue to violet variety of calcite that is found both as cuboid crystals and massive. (Standard)

Brunoing (Ark. and Mo.). Pulling fine ore down from the working place, especially with the hands. From its similarity to the action of a bear. (J. J. Rutledge)

Bruno man (Ark. and Mo.). One who removes fine ore from a working place, especially when the work is done with the hands. *See also* Brunoing.

Brunstone. A Scotch form of brimstone. (Century)

Brunton. A small pocket compass with sights and a reflector attached, used in sketching mine workings, as in mine examinations, or in preliminary surveys.

Brunton's sampler. A mechanical sampling device which automatically selects 1/625 part of the ore passing through the sampler. (Hofman, p. 57)

Brush. 1. (Mid.) To mix gas with air in the mine by buffetting it with a jacket. 2. (Forest of Dean.) A rich brown hematite. (Gresley)
3. To shoot or wedge down some of the rock over a roadway to increase the height of head-room. Less often, to take up bottom for the same purpose. (Steel)

Brush hook. A short heavy hook with an axe handle, used by surveyors for cutting brush.

Brushers (Scot., Som.). Men who brush the roof, build packs and stoppings (Gresley). *See also* Brush 3. Also called Stonemen.

Brushing. 1. (Scot.). That part of the roof or floor of a seam removed to form roadways. (Barrowman)
2. Digging up the bottom or the taking down the top of an entry or room for the purpose of admitting cars where the seam of coal is too thin or shallow for the admission of cars. *See* Brush, 3. (Williams *v.* Craig Dawson Coal Co., 146 Northwestern, p. 736)

Brushing bed (Scot.). The stratum brushed or ripped (Gresley). *See also* Brush, 3.

Brushing shot. 1. A charge fired in the air of a mine to blow out obnoxious gases, or to start an air current. (Du Pont)
2. A shot so placed as to remove a portion of the roof to increase height of a haulage way. *See also* Brush, 3.

Brushite. A nearly colorless acid phosphate of calcium, $HCaPO_4 + 2H_2O$, in slender crystals or massive. (Webster)

Brush ore. An iron ore in brushlike or stalactitic forms (Webster). *See also* Brush, 2.

Bruskins (Mid.). Lumps of coal weighing about one pound each. (Gresley)

Bryan mill. A three-roll (edge-roller) mill of the Chilean type.

Bryle (Corn.). *See* Broil.

B. S. oil. A term applied to crude-oil tank residues. *See also* Bottom settlings. (Bacon)

B. t. u. An abbreviation for British thermal unit.

Bubble. A globule of air or other gas in a liquid; also a vesicle of water or other liquid inflated with air or other gas (Rickard). A term used in flotation.

Bucaramangite. A resin resembling amber but insoluble in alcohol and yielding no succinic acid. (Bacon)

Buche (Port.). A pocket or bunch of ore. (Halse)

Buchnerite. A name proposed by Wadsworth for those peridotites, terrestrial and meteoric, which consist of olivine, enstatite (bronzite) and augite. The name was given in honor of Dr. Otto Buchner, an authority on meteorites. (Kemp)

Buchonite. A special name given by Sandberger to a nephelite-tephrite that contains hornblende. (Kemp)

Buck. 1. To break up or pulverize, as ores. 2. To carry, as to buck water. (Webster)

Bucker 1. (Derb.). A flat piece of iron with a wooden handle, used for breaking ore. (Raymond)
2. One who bucks or breaks ore.
3. (Washington). A laborer who pushes coal down a chute in pitching or inclined coal seams.

Bucket. 1. A vessel for hoisting and conveying water, coal, ore, or grain. A tub or scoop of which there are several types. 2. One of the receptacles on the rim of a water wheel into which the water rushes causing the wheel to revolve. (Webster)
3. The piston of a well pump. It always contains a valve. It is connected to and operated by the sucker rods. (Nat. Tube Co.)

Bucket door (Scot.). The cover of an opening in pipes for access to the pump bucket. (Barrowman)

Bucket-door piece (Eng.). The portion of a set of pumps immediately above the working barrel, having a removable door through which the bucket is changed; the bucket door is secured to the bucket-door piece by bolts. (G. C. Greenwell)

Bucket dredge. A dredge in which the material excavated is lifted by an endless chain of buckets. (Weatherbe)

Bucketing (Eng.). The operation of removing a worn-out pump bucket or clack, and replacing it with a new one. (Gresley)

Bucket lid (Scot.). The flap of a bucket valve. (Barrowman)

Bucket lift (Eng.). The iron pipes of a mine pump. (Bainbridge)

Bucket line. The series of joined buckets forming part of the digging apparatus of a dredge. (Weatherbe)

Bucket machine. *See* Elevator pump.

Bucket mounting (Scot.). Leather or gutta-percha packing of a pump bucket. (Barrowman)

Bucket piece (Scot.). The pipe carrying the bucket door of a pump. (Barrowman)

Bucket pump. 1. A lifting pump. 2. An iron or wooden receptacle for hoisting ore, or for raising rock in shaft sinking. (Chance)

Bucket rods (Eng.). Wooden rods to which a pump piston is attached. (Bainbridge)

Bucket shell (Scot.). The cast-iron or brass frame of a pump bucket. (Barrowman)

Bucket sword (Eng.). A wrought-iron rod to which a pump bucket is attached, having at its upper end a knocking-off joint. (Gresley)

Bucket tree (Eng.). The pipe between the working barrel and the windbore of a pump. (Gresley)

Bucking (Derb.). The act of breaking or pulverizing ore. The bucking hammer or bucking iron is a broad headed hammer used for this purpose; and the ore is broken on a flat piece of iron (bucking plate). (Raymond)

Bucking hammer. *See* Bucking.

Bucking iron. *See* Bucking; Bucking plate.

Bucking ore. A hand process of crushing ore. (Woodson)

Bucking plate. An iron plate on which ore is ground by hand by means of a muller. Extensively used for the final reduction of ore samples for assaying. Also called Bucking iron.

Bucklandite. 1. A black variety of epidote having a tinge of green, and differing from ordinary epidote in having the crystals nearly symmetrical and not, like other epidote, lengthened in the direction of the orthodiagonal. 2. Anhydrus allanite in small black crystals. (Dana)

Bucklers; Tacklers (Derb.). Small chains put around the coal when loaded in corves, to prevent it falling off. (Min. Jour.)

Buckling. The act of bending; tendency to bend or become wavy. (Century)

Buck quartz (Aust.). Non-auriferous quartz. (Power)

Buckshot (Aust.). Granulated lava imbedded in a sandy alluvium. (Standard)

Buckshot cinder. Cinder from the iron blast furnace, containing grains of iron. (Winchell)

Buckshot land; Buckshot soil. Land or soil containing many limonitic nodules. (Standard)

Buck staff. *See* Buckstay.

Buckstay. An upright iron or steel brace resting upon or built into a boiler setting or furnace wall to support the brickwork. (C. M. P.)

Buckstone. Rock not producing gold (Duryee). *Compare* Buck quartz.

Buck-up (Eng.). A contribution by shareholders. (Bainbridge)

Buckwheat; Buckwheat coal. In anthracite only. Buckwheat is divided into four sizes: No. 1, or buckwheat; No. 2, or rice; No. 3, or barley; No. 4, or barley No. 2, or silt (sometimes also called culm or slush). Buckwheat No. 1 passes through a ½-inch woven wire screen and over a $\frac{5}{16}$-inch woven wire screen, through a $\frac{9}{16}$-inch round punched plate and over a ⅜-inch round punched plate. The American Institute of Mechanical Engineers has recommended that buckwheat No. 1 shall pass through $\frac{9}{16}$-inch holes and over $\frac{5}{16}$-inch holes, a screen with circular holes being used.

Buckwheat slate. A friable slate (shale) that requires careful timbering in headings driven through it. It crumbles badly at or near the surface of the ground.

Buddagh (Leinster, Ireland). A highly carbonaceous, soft, muddy-looking fire clay. (Power)

Buddle. 1. (Corn.). An inclined vat, or stationary or revolving platform, upon which ore is concentrated by means of running water. Strictly the buddle is a shallow vat, not a platform or table; at least not in some localities. But general usage, makes no distinction. (Raymond) 2. To separate (ore) from slime or stamp work by means of a buddle. (Standard)

Buddler (Derb.). One who searches old workings for ore. *Compare* Caver, 1. (Mander)

Buddle work (Eng.). Dressed and partly-dressed ore obtained from the buddle. (Hunt)

Buddy. A partner. Each of two men who work in the same working place of a coal mine. Sometimes spelled Butty. (Steel)

Bufa (Mex.). 1. Cliff or precipice. 2. At Mazapil, brown iron ore and malachite. (Halse)

Bufador (Sp.). A blower or sudden outburst of gas. (Halse)

Buffer. 1. An elastic apparatus or fender for deadening the jar caused by the collision of bodies. Anything serving to deaden a shock. (Webster)
2. A rotating head covered with felt or other soft material. It is supplied with a fine polishing powder and is employed to polish the surface of stone. (Bowles)

Buffer bar. The heavy iron bar in a railroad car which receives the impact of the other cars. (Webster)

Buffer beam (Scot.). Beams fixed in a shaft to prevent pump rods from traveling too far. (Barrowman)

Buffer block. A block serving as a buffer. (Webster)

Buffer rope (Aust.). A rope suspended between the cages in a shaft where rope guides are employed, so as to prevent the cages from colliding. (Power)

Buffer shooting. Same as Blanket shooting. (Bowles)

Buffer-thimble. A cast-iron bushing on the end-timber of the platform of a car. (Standard)

Buffing machine. A machine used for buffing or polishing. (Century)

Buff stick. A piece of stick covered with leather or velvet and charged with emery or other powder, used in polishing. (Century)

Buff ware (Staff.). A stoneware made from clay and other ingredients; it is not decorated. (Century)

Buff wheel. An emery wheel. (Webster)

Bug dust. The fine coal or other material resulting from a boring or cutting of a drill, mining machine, or even a pick. This is sometimes wrongly used as a tamping or stemming material in coal mining (Du Pont). *See also* Makings.

Buggy. A small wagon or truck used for short transportation of heavy material as coal in a mine, lumber, steel ingots, etc. (Webster). A four-wheeled steel car used for hauling coal to and from chutes. (Sabela v. Newport Min. Co., 184 Michigan, p. 677)

Bug hole. A small cavity, in a rock, usually lined with crystals (C. and M. M. P.). *See also* Vug.

Bugre (Braz.). Pockets of yellow clay, rich in gold, found especially in contact with the itabirites and quartzites. (Halse)

Buhrstone. A silicified fossiliferous limestone, with abundant cavities which were formerly occupied by fossil shells. Its cellular character and toughness occasioned its extensive use as a millstone in former years (Kemp). Also spelled Burrstone, and Burstone.

Buildhouse. *See* Bildas.

Builders-up (Eng.). Men who make packs and set timber, in ironstone mines. (Gresley)

Building (Som.). A built-up block, or pillar of stone or coal to carry the roof (Gresley). *See also* Cog.

Building stone. 1. (Som.) Sandstone or other rock suitable for pack building (Gresley). *See also* Sandstone. 2. Stone suitable for use in masonry construction.

Built-up. *See* Chunked-up.

Buitrón. 1. (Sp.) A low blast furnace for smelting silver ore. 2. (Mex.) Fire box. 3. (Peru) A masonry sump for settling pulp after grinding and before taking it to the *patio*. (Dwight)

Bujia (Mex.). A candle; candle power. (Dwight)

Bule. 1. (Eng.) A bit of iron put round pistons. (Bainbridge)
2. (Derb.) The handle or bail of an ore bucket. (Hooson)

Bulk (Brist.). Run-of-mine coal in large quantities. (Gresley)

Bulkhead. 1. A tight partition or stopping in a mine for protection against water, fire, or gas. 2. The end of a flume, whence water is carried in iron pipes to hydraulic workings. (Raymond)
3. A solid crib used to support a very heavy roof. *See also* Cog; Chock.

Bulk-oil flotation. A flotation process in which large amounts of oil are used. (Ralston)

Bull. 1. (No. of Eng.) An iron rod for preparing a shot-hole in watery ground when the hole has to be lined with clay (Gresley). *See also* Clay iron.
2. (Aust.). *See* Drag, 1 and 2; *also* Backstay.

Bull bit. A flat drill bit. (Gillette)

Bulldog. 1. A refractory material used as furnace-lining, got by calcining mill-cinder, and containing silica and ferric oxide. 2. (Penn.) *See also* Buckshot-cinder. (Raymond)

Bulldoze (U. S.) To reduce broken rock by the use of explosives to a size handy for raising to the surface (Skinner). *See also* Mud cap; Secondary blasting.

Bull engine. A single-acting pumping engine constructed upon the direct-acting principle (Gresley). *See also* Bull pump.

Buller shot. 1. (Som.) A second shot put in close to and to do the work not done by a blown-out shot, loose powder being used. (Gresley)
2. (Scot.) A blown-out shot (Barrowman). Also called Buller.

Bulletin. 1. A large tabulation sheet on which the weight of each car load of coal each miner sends out is entered. Also called Coal bulletin. (Steel)
2. A brief or condensed statement of news to the public, as issued by an acknowledged authority. A periodical. (Webster)
3. A class of publications issued by the U. S. Bureau of Mines; U. S. Geological Survey. etc.

Bulletin board. A board on which bulletins are posted (Webster). *See also* Bulletin, 1.

Bullfrog. *See* Barney.

Bulling. 1. The dislodging of rock by exploding blasting charges in fissures. (Webster)
2. Lining a shot hole with clay. (C. and M. M. P.)

Bulling bar. An iron bar used to pound clay into the crevices crossing a bore hole, which is thus rendered gas-tight (Ihlseng). *Compare* Bull, 1.

Bulling shovel. A triangular, sharp-pointed shovel used in ore dressing. Also called Vanning shovel. (Century)

Bullion. 1. Uncoined gold and silver. Base bullion is usually pig lead containing but little gold or silver. (Lawver)
2. Gold and silver coined but considered simply with reference to its commercial value as raw material. 3. Figuratively, solid gold and silver, as distinguished from mere imitations; hence solid worth. (Standard)

Bullion balance. A sensitive beam balance of heavy construction used for weighing bullion and specie. (Webster)

Bullion bar. 1. Unrefined gold or silver melted and cast into a bar. (Weed)
2. A bar upon which the molten glass at the end of a blowing tube is rested to assist in bringing it into special shape. (Webster)

Bullions (Lanc.). Nodules of clay ironstone, pyrite, shale, etc., which generally inclose a fossil. (Gresley)

Bull point. A large steel point driven with a sledge. (Bowles)

Bull pump (Corn.). A direct single-acting pump, the steam cylinder of which is placed over the top of a shaft or slope, and the piston rod attached to the pump rods. The steam lifts piston and pump rods and the weight of these produces the down stroke. (Raymond)

Bull pup. A worthless mining claim. (C. and M. M. P.)

Bull rope. In well boring, the rope from which the boring tools are suspended and by which they are worked. (Webster)

Bull's eyes. Nodules of pyrite in roofing slate. (Power)

Bull's-eye tuyère. A tuyère discharging in the center of a hemispherical plate. (Standard)

Bull wheel. 1. In well drilling, a wheel on which the bull rope is wound. 2. An underground sheave wheel. Particularly the wheel around which the tail rope is passed beyond each terminal of a tail-rope haulage system. (Steel)

Bully. A pattern of miners' hammer, varying from "broad-bully" to "narrow-bully." (Raymond)

Bullying. *See* Springing.

Bumicky. A combination of powdered stone and cement used to fill crevices made by the accidental chipping, as of building stones: a stonemason's term. (Standard)

Bumming. 1. (Scot.). Heaving or rising of the pavement or floor 2. Emitting a hollow sound when struck. (Barrowman)

Bump (Eng.). 1. A sudden breaking sometimes accompanied by a settling or upheaval of the strata in the mine, accompanied by a loud report. Also called Crump (Gresley). *See also* Bounce, 1. The term is not in common use among the miners in this country, and has been interpreted by many to indicate a sudden squeeze, or buckling of the floor or walls of the mine passage-ways. This is not the case, as the word is practically synonymous with "jar." It has its origin in the shocks accompanying earth movements. (Geo. S. Rice, chief mining engineer, U. S. Bur. Mines)

Bumper. *See* Buffer, 2; Catches, 3.

Bumping and jerking tables. These machines use mechanical agitation to bring the light and heavy grains into their respective layers on a washing surface, and they use a bumping or jerking action to convey the heavy grains to one side or the other of the machine, while the current of surface water conveys the light grains to another side or end. They may be either side-bump, having the bump or jerk at right angles to the flow of water, or end-bump, having the bump or jerk in the opposite direction from the flow of the water. *See also* Rittinger, Bilharz, Wilfley, Bartlett, and Overstrom. (Liddell)

Bumping post. A post placed as a buffer at the end of a spur of railroad track. (Webster)

Bumping trough. A sheet iron trough hung from plugs so that it may be swung backward and forward and used for handling ore in stopes where the dip is such that the ore will not "'run." (H. C. Hoover, p. 136)

Bump knocker. Local term at Spadra (Arkansas) for a person who picks down portions of machine-mined coal which have not been shot down by blasting. (Steel)

Bunch. 1. A small quantity of ore in a compact mass in the vein. (Whitney)
2. A portion of a pipe vein of greater thickness than the rest. (Standard)

Bunch of ore (Corn.). An ore body, usually a small one. (Raymond)

Bunchy. An ore body containing small scattered masses or bunches of ore. (Weed)

Bunchy reef (So. Afr.). A succession of blows, or outcrops, following a certain course (Power). *See also* Blow, 2 and 6.

Bunding. A staging of boards on stulls or stemples, to carry deads. *See also* Stull-covering. (Raymond)

Bunk. A frame attached to a wall or partition, which serves as a bed or sleeping place (Webster). Common in mining and lumber camps.

Bunker coal. A term applied to coal consumed by ocean steamers, tugs, ferry-boats, or other steam water craft (Nicolls). Also called Bunkers.

Bunker Hill screen. A rotating screen shaped like a funnel. Material is delivered inside the funnel, the undersize passing through the screen, while the oversize is discharged through the funnel neck. (Liddell)

Bunker plate. An iron plate covering a hole in a ship's deck leading to the coal bunker. (Century)

Bunkers (Wales). *See* Bunker coal.

Bunky (Ill. and Wis.). In metal mines, a partner; called Buddy in coal mines.

Bunney. *See* Bonny.

Bunning (Eng.). In lead mining, a floor or staging of wood built across the lode over the miners' heads, and on which the refuse was thrown, so that the mine, originally begun as an open work, became covered over for its whole length except the windlass opening (Century). Also spelled Bunding.

Bunter sandstone (Eng.). A sandstone at the base of the Triassic system in western Europe. (Cox)

Buntons. Timbers placed horizontally across a shaft. They serve to brace the wall-plates of the shaft-lining, and also, by means of plank nailed to them, to form separate compartments for hoisting or ladder-ways. (Ihlseng)

Buoy. To keep from sinking; to keep afloat in a liquid. A term used in flotation. (Rickard)

Buque (Mex.). A boy employed in a mine. (Dwight)

Bur; Burr. 1. A mass of flint rock in a softer rock. 2. A burrstone or buhr. (Standard)

Burbuja (Sp.). A bubble, bleb or blister. (Halse)

Burbusco (Panama). Extracting the rich ore; spoiling. (Lucas)

Burbusero (Panama). A spoiler (Lucas). *See also* Barequero.

Burden (Corn.). 1. The tops or heads of stream-work, which lie over the stream of tin. 2. The proportion of ore and flux to fuel in the charge of a blast-furnace. (Raymond)
3. Valueless material overlying the ore, especially such as is removed by stripping. Frequently called Overburden. (Webster)
4. The distance between the charge and the free face of the material to be blasted. (Du Pont)

Bure (Fr., Belg.). A coalpit. (Gresley)

Bureau. A department or office of the Government for the transaction of public business (Webster). As the Bureau of Mines.

Burette. An apparatus used in chemical laboratories for delivering measured quantities of liquid or gas. (Webster)

Burgy (Lanc.). Slack, or small coal. (Gresley)

Buried placers. Old placer deposits which have become buried beneath lava flows or other strata. (Shamel, p. 279)

Buried rivers. River-beds which have been buried below streams of basalt or alluvial drifts. (Duryee)

Burilada (Sp.). A sample chipped from silver bullion, to be assayed. (Halse)

Burk. A hard knot or lump in a vein. (Power). Possibly a corruption of burl which means a knot, lump or an excrescence.

Burleigh. *See* Rock drill.

Burmite. A fossil resin, resembling amber, but harder and tougher; it occurs in Upper Burma. (Bacon)

Burned. Said of slate or other impurity that adheres tightly to the coal. Similarly, coal is said to be "burned to the roof" when it is hard to separate the roof rock from the coal.

Burner; Burner man. A man who takes care of kilns for roasting ore, largely confined to plants roasting sulphur from Cornwall ores. (Willcox)

Burning. 1. Same as Calcining. *See also* Calcine. 2. (Derb.) An old method of working veins by softening them with fire. *See also* Firing, 8. (Mander)

Burning house. The furnace in which sulphide ores are calcined to sublime the sulphur; a kiln. (Century)

Burning mountain. A volcano. (Webster)

Burning oil. A common name for kerosene.

Burning point. The temperature at which a volatile oil in an open vessel will ignite from a match held close to its surface: formerly used to determine the safety of kerosene and other illuminants. (Standard)

Burnt alum. A white porous substance obtained by heating ordinary alum to dull redness, thus expelling the water of crystallization and some of the sulphuric acid. (Webster)

Burnt brass. Blue vitriol. (Webster)

Burnt coal (Scot.). Coal altered by an igneous rock intrusion (Barrowman). *See also* Natural coke.

Burnt copper. Copper oxide. (Webster)

Burnt-in. In ceramics, said of colors that have been applied under the glaze, and are fired with it. (Century)

Burnt iron. 1. Iron which by long exposure to heat has suffered a change of structure and become brittle. It can be restored by careful forging at welding-heat. 2. In the Bessemer and open-hearth processes, iron which has been exposed to oxidation until all its carbon is gone, and oxide of iron has been formed in the mass. (Raymond)

Burnt ore. Roasted ore.

Burnt stone. An antique carnelian such as is sometimes found in ancient ruins and has apparently been acted on by fire. (Century)

Burnt stuff. 1. (Mid.). Waste or refuse coal that has been thoroughly burned by spontaneous combustion. (Gresley)
2. (Aust.). An intensely hard, rocky stratum underlying the surface-soil. (Standard)

Burnt umber. *See* Umber.

Burr (Derb.). A hard knot or lump in a vein. A lump of ore that is harder than the vein itself (Hooson). Also spelled Bur; Burk.

Burrell gas detector. A device to obtain a safe, rapid and accurate determination for low percentages of methane inside the mine. Complete combustion of the methane takes place within the apparatus, and the percentage is measured volumetrically.

Burrero (Mex.). A donkey boy. (Dwight)

Burro (Mex.). A windlass; a donkey; a carpenter's horse. (Dwight)

Burrow (Corn.). A heap of refuse. (Raymond)

Burrstone. A cellular but very compact siliceous rock from which the best millstones are made (Standard). Also called Bur; Burr, and Buhrstone.

Burster; Bursting shot 1. (Scot.). A shot in a coal seam which has not been sheared or undercut. (Barrowman). Equivalent to "shot off the solid."
2. *See* Buster.

Bursting charge. A small charge of fine powder, placed in contact with a charge of coarse powder to insure the ignition of the latter. (Century)

Burst of whinstone (Scot.). A bed or mass of igneous rock at the surface of the ground. (Barrowman)

Burt filter. A stationary, intermittent filter in which the leaves are suspended vertically in a cylindrical vessel set on a considerable incline. The leaves are therefore ellipses. The slime cake is discharged by introducing air and water into the interior of the leaf. There is also a newer Burt filter of the continuous rotating-drum type. (Liddell)

Burthen (Scot.). The load of coal which the bearers carry on their backs. (Barrowman)

Burton. Any of several kinds of tackle, usually one with a single and double block. *See also* Tackle, 2. (Webster)

Bury (Ireland). Soft shale or clay; flucan. (Century)

Bus bar. A copper or aluminum conductor used in electric lighting or power stations to receive the current from all the dynamos, or distribute it to the motors, etc. (Century)

Busca. 1. (Mex.). A quantity of ore extracted by a *campero* or *buscón*. (Dwight)
2. (Sp.). A search.

Buscador. A searcher; an investigator (Vel.). (Min. Jour.).

Buscar (Sp.). To search for mines; to prospect. (Halse)

Buscón (Mex.). 1. A miner working in abandoned mines either to get and sell ore, or to obtain a reward for some valuable discovery. Prospector. *See also* Campero. (Dwight) 2. A petty robber. (Vel.)

Bushel. A measure of capacity, the imperial bushel, of 2218.192 cubic inches, and the Winchester bushel, of 2150.42 cubic inches, being divided into 4 pecks. The bushel used in measuring charcoal and coal contains 5 pecks, or 2688 cubic inches, being 20 pounds or less of charcoal, and, in various localities, 80, 76, or 72 pounds of coal (Raymond). The Winchester bushel is the standard for the United States.

Bush hammer. A hammer having a serrated face, as of rows of pyramidal points, for dressing stone.

Bushing. A pipe fitting for the purpose of connecting a pipe with a fitting of larger size, being a hollow plug with internal and external threads to suit the different diameters. (Nat. Tube Co.)

Bush metal. An alloy used for journals, bearings of shafts, etc. (Century)

Bustamente furnace. A cylindrical shaft furnace for roasting quicksilver ores; divided by perforated arches into two compartments, of which the upper receives the ore and the lower the fuel. The mercury-vapors are condensed in aludels. (Raymond)

Bustamite. A grayish-red variety of rhodonite containing lime. (Dana)

Buster (really Burster) (Eng.). A machine for breaking down coal, without the use of explosives. (Gresley)

Buster shot. Same as Breaking-in shot.

Bustle. 1. (York.) Hurry in mining or working coal, or in performing other colliery work. (Gresley) 2. A board put on the end of a car to keep coal on the car when going up or down a steep slope.

Bustle pipe. A large pipe surrounding a blast furnace, which receives the blast from the stoves and delivers it to the tuyères. (Tieman)

But (Scot.). Outwards; toward the shaft (Barrowman). Outbye.

Butracos (Sp.). Inclined shafts following the dip of lead and zinc lodes. (Halse)

Butt. 1. (Eng.). Of coal, a surface exposed at right angles to the face. *See also* End, 1. (Raymond) 2. The butt of a slate quarry is where the overlying rock comes in contact with an inclined stratum of slate rock. (Merrill)

Butt cleat. A short, poorly defined cleavage plane in a coal seam usually at right angles with the face cleat. *Compare* Face cleat.

Butte. A conspicuous isolated hill or small mountain, especially one with steep or precipitous sides. (Webster)

Butt-entry. The gallery driven at right-angles with the butt cleat. An end-on entry.

Butterfly. 1. The name applied to certain valves made after the design of a damper in a stove pipe. 2. In pumps this term signifies a double clack-valve whose flaps work on a diametral hinge, like the wings of a butterfly. (Nat. Tube Co.)

Butterfly valve. *See* Butterfly.

Butter of tin. Stannic chloride. (Standard)

Butters' filter. A stationary, intermittent vacuum filter. The leaves are arranged in a box having a pyramidal bottom. When the pulp is introduced a vacuum is applied until a cake from 1 to 2 in. in thickness is formed. The surplus pulp is then removed from the box and wash solution or water introduced and the cake washed. After removing the wash solution, either the box is filled with water, or the cake dropped and sluiced out. (Liddell)

Butt heading. *See* Butt entry.

Butt-joint. *See* Butt cleat.

Buttock (Eng.). That portion of a working face of coal, next to be taken down. (Gresley)

Buttocker (Eng.). One who breaks down the coal that has been undercut by the holers. A getter. (Redmayne)

Button. The globule of metal remaining on an assay-cupel or in a crucible, at the end of the fusion. (Raymond)

Button balance. A small, very delicate balance used for weighing assay buttons. (C. and M. M. P.)

Button metal. A variety of brass composed of one part copper and four parts zinc. (Webster)

Button solder. A white solder composed of tin, brass and copper, used as a substitute for silver solder in making buttons. (Century)

Butt shot. In coal mining, a charge placed so that the face or burden is nearly parallel with the bore hole. (Du Pont)

Button strike. A strike to compel every employee to join the union and to pay the dues regularly. On payment of dues, each man is given a button to wear on his hat.

Buttweld. Welded along a seam that is not scarfed or lapped. (Nat. Tube Co.)

Butty. 1. A comrade; a chum or partner. 2. (Eng.) In coal mining, one who takes a contract, or is a partner in a contract for working out a certain area of coal (Century). Also spelled Buddy.
3. (Mid.) A man who sorts and loads the coal, for which he is paid by the ton. Known as a Butty banksman. (Gresley)

Butty collier (Eng.). A foreman of a butty gang. (Standard)

Butty gang (Eng.). A company of men who undertake work by contract and divide the profits among themselves. (Standard)

Buttyman (York). A contractor who mines coal. *See also* Butty. (Gresley)

Buttyship (So. Staff.). The prevailing mode of working the "Ten-yard" coal seam. The contractor mines, loads, and delivers coal to place of sale, finding all tools, horses, skips, corn, candles, powder, pit beer, etc. The masters find timber, engine-power, and loaders at the boats. (Gresley)

Butty system (So. Staf., No. Staff., Mid.). The working of a pit or mine by contract. *See also* Buttyship. (Gresley)

Butyrellite. A white or yellow waxy substance found in certain of the Irish and Scotch bogs. (Bacon)

Buzamiento (Sp.). Hade, dip, inclination, slope. (Lucas)

Buzo (Colom.). Divers who get alluvial gold from the bottom of rivers with *bateas*. (Halse)

Buzón (Sp). 1. A funnel-shaped hopper. 2. A winze. 3. A subsidence of upper workings produced by a funnel-shaped cave of ground below. (Halse)

Byard. A leather breast strap used by miners in drawing carloads of ore or coal. (Standard)

Byat. *See* Biat.

Bye chains (Wales). Hauling ropes, or chains for dip inclined planes. (Gresley)

Byerite. A caking bituminous coal from Middle Park, Colo. It resembles albertite in the large amount of gas and oil which it yields upon distillation. (Bacon)

Byerlite. An artificial asphalt made from petroleum by driving off the volatile products. (Webster)

Bywork (Mid.). Odd work, or that which is paid for by the day, in connection with the underground roads. The men who perform it are called By-workmen. (Gresley)

By-lead. *See* By-wash.

By-level. A side level driven for some unusual but necessary purpose. (C. and M. M. P.)

By-pass; Bye-pass. 1. A short passage used to get by or around a place it is not advisable to cross, *e. g.*, a mine shaft. (Power)
2. A small passage to permit equalization of the pressure on the two sides of a large valve so that it may be readily opened or closed (Nat. Tube Co.). An extra gas pipe passing around a valve or gas chamber used to prevent a complete stoppage of the flow of gas when the valve or chamber is closed. (Century)

By-pit. (Scot.). A pit nearer the outcrop than the engine pit; an air pit. (Barrowman)

By-product. A secondary or additional product (Webster). *e. g.* The more common by-products of coke ovens are gas, tar, benzol and ammonium sulphate.

By-product oven. A coke oven consisting of a series of long narrow chambers arranged in rows, and heated by flues in which are burned a portion of the combustible gases generated by the coking of the coal. All of the volatile products are saved and collected as ammonia, tar and gas, etc.

By-road (Scot.). A subsidiary road. (Barrowman)

Bysmalith. A name suggested by J. P. Iddings for an igneous intrusion that forms a huge cylindrical mass or plug, with length and width approximately the same, but of relatively great height. (Kemp)

Bysolite. An olive-green fibrous variety of amphibole. (Webster)

Bytownite. A plagioclase feldspar having a composition between labradorite and anorthite. (Dana)

By-wash. A channel cut to convey the surplus water from a reservoir or an aqueduct, and prevent overflow. Also called By-lead. (Century)

C.

Cab (Eng.). A hard ferruginous gouge or casing between the unaltered country rock and the ore. *See also* Casing, 2.

Caballeriza (Mex.). Stable. (Dwight)

Caballero (Sp.). A spoil bank. (Lucas)

Caballete (Mex.). Ridge-beam, trestle, etc. *C. de tension*, tension station of a cable tram. (Dwight)

Caballo (Sp.). 1. A miner's candlestick. 2. A rope sling for lowering men in a shaft. (Dwight)
3. A horse. 4. Barren rock in a lode or vein. 5. A grinding stone in an *arrastre*. 6. A cofferdam. (Halse)

Cabble. To break up into pieces (as charcoal iron) preparatory to the processes of faggoting, fusing and rolling into bars. (Century)

Cabecedo (Mex.). The end-line of a claim. (Dwight)

Cabeceira (Braz.). 1. A horizontal portion of a sluice. 2. A level heading. (Halse)

Cabecera (Mex.). "Heads" obtained in ore concentration. (Dwight)

Cabecilla. 1. (Sp. Am.). Slimes or sand in the washing trough. (Lucas)
2. Coarse ore which is reground.
3. In the *patio* process the residue after washing the *torta*. (Halse)

Cabeza. 1. (Mex.). Head or end. 2. *C. de ingenio* (Peru), the shaft of a vertical water-wheel. (Dwight)
3. (Colom.) The upper extremity of a placer mine. 4. (Mex.) An outcrop. (Halse)

Cabezada (Mex.). The end piece in shaft-timbering. (Dwight)

Cabezal (Mex.). A cap used in mine timbering. (Dwight)

Cabezón (Colom.). The point at which a current of water loses its velocity, and deposits the suspended material. (Halse)

Cabezuela (Mex.). Rich concentrates, usually containing both gold and silver. Mineral crushed to less than ¼ in. in diameter. (Dwight)

Cabin. A small room, either on the surface or underground, *e. g.*, a lamp cabin, or a deputy's cabin. (Power)

Cable. 1. Same as cable-laid rope; a fiber cable consists of three hawsers laid up left-handed. (C. M. P.)
2. A bundle of insulated wires, insulated by an outside wrapping, forming a water-proof electrical conductor, as a submarine cable. (Webster)
3. A steel rope for hoisting or for aërial trams.

Cable (Mex.). Cable or hoisting-rope; *C. de porte*, carrying rope; *C. de tracción, de motor, de móvil*, traction-rope; traveling-rope. (Dwight) *C. de cola*, tail rope; *C. rastrero*, haulage rope; *C. eléctrico*, electric cable or wires. (Halse)

Cable drill. *See* Churn drill.

Cable-laid rope. Wire cables made of several ropes twisted together, each rope being composed of strands twisted together without limitation as to the number of strands or direction of twist. A fiber cable-laid rope is composed of strands of hawser-laid rope, twisted right-handed. (C. M. P.)

Cable's length. The length of a ship's cable, usually about 600 feet, or one-tenth of a nautical mile. (Webster)

Cable system. One of the well-known drilling systems, sometimes designated as the American or Rope system. The drilling is performed by a heavy string of tools suspended from a flexible manila or steel cable to which a reciprocating motion is imparted by its suspension from an oscillating "walking beam." One end of the walking beam is above the mouth of the well when horizontal, and the other end is directly above a crank attached to the band-wheel shaft. (Mitzakis)

Cable tools. The apparatus used in drilling deep holes, such as artesian wells, with a rope, instead of rods, to connect the drill with the machine on the surface. (Raymond)

Cable-vía aéreo (Mex.). Aërial cable tramway. (Dwight)

Cabo (Mex.). 1. Handle. 2. Stump of candle. 3. Sub-foreman, or boss. (Dwight)

Cabocle. A compact rolled pebble resembling red jasper, supposed to be hydrous aluminum-calcium phosphate: found in the diamond-producing sands of Bahia, Brazil. (Standard)

Cabrerite. A hydrous arsenate of nickel, cobalt and magnesium, found in green crystals and in masses. (Dana)

Cabrestante (Mex.). Capstan; winch. (Dwight)

Caçamba (Braz.). The bucket of a gold dredge. (Halse)

Cache (Fr.). The place where provisions, ammunition, etc. are cached or hidden by trappers or prospectors in unsettled regions. (Raymond)

Cachetear (Mex.). To loosen a gad by striking it alternately on each side. (Dwight)

Cachi (Peru). A "Quechua" word, meaning salt; also applied to all kinds of white gangue-rocks. (Dwight)

Cacho (Colom.). A piece of horn used in gold washing (Halse). A horn spoon.

Cacholong. An opaque bluish-white or pale-yellow opal, containing a little alumina. (Dana)

Cachucha (Mex.). A miner's cap. (Dwight)

Caco (Braz.). A sugary quartz found in gold veins. (Century)

Cacoxenite. A hydrous phosphate of iron, $FePo_4Fe(Oh)_3+4\frac{1}{2}H_2O$, occurring in yellow or brownish radiated tufts. (Dana)

Cadena (Sp.). 1. Chain. A unit of linear measurement. (Dwight) 2. *C. de rocas*, a ledge or ridge of rocks. (Halse)

Cadge (Derb.). To attach the hoisting rope to an ore bucket; also to fasten tools in the bucket with a rope to prevent them falling out. (Hooson)

Cadger. A little, pocket oil can for miners. (Min. and Sci. Press, Aug. 28, 1915)

Cadmium. A tin-white, malleable, ductile metal, capable of a high polish and emitting a crackling sound when bent. Symbol, Cd; atomic weight, 112.40. Specific gravity, 8.6. (Webster)

Cadmium ochre. The mineral greenockite. (Standard)

Caducar (Mex.). To forfeit a title through noncompliance with the stipulations contained therein. (Dwight)

Caducidad (Mex.). The act of forfeiting a title, etc. (Dwight). *See also* Caducar.

Caen stone. A light cream-colored Jurassic limestone, chiefly from Caen, Normandy, largely used in carved architectural work. (Standard)

Caer de cruz (Mex.). The beginning of the action of the quicksilver in the process of amalgamation. (Dwight)

Caesium. A soft, silvery metal, closely resembling rubidium and potassium. Symbol, Cs; atomic weight, 132.81. Specific gravity 1.84 (Webster)

Cage. 1. A frame with one or more platforms for cars, used in hoisting in a vertical shaft. It is steadied by guides on the sides of the shaft. 2. A structure of elastic iron rods slipped into the bore-hole in rod-boring to prevent vibration of the rods. 3. The barrel or drum of a whim on which the rope is wound. (Raymond)

Cage cover (Scot.). The iron sheets fixed above a cage to protect its occupants (Barrowman). A hood. *See also* Bonnet, 1.

Cage guides. 1. Vertical pieces of wood, iron, or steel, fixed in a shaft, between which cages run, and whereby they are prevented from striking one another, or against any portion of the shaft. (Steel) 2. (Scot.) Shoes, usually cast iron, clasping the guides (*see* Cage guides, 1) in a shaft and guiding the cage in its movements in the shaft. (Barrowman)

Cage iron. In foundry practice a core iron resembling a cage. (Webster)

Cage of a whim (Corn.). The barrel on which the rope is wound (Min. Jour.). A drum.

Cager. 1. The person who puts the cars on the cages at the bottom of the mine shaft, or at intermediate landings. (Steel) *See also* Top cager.
2. One who supervises weighing, and the sequence of sending up components of a furnace charge, keeps tally of the number of charges and signals to top filler when it is time to hoist. (Willcox)

Cage seat. Scaffolding, sometimes fitted with strong springs, to take the shock, and on which the cage rests when reaching the pit bottom, or other landing (Steel). *See* Cage shuts.

Cage shuts. (Som.). Short props or catches upon which cages stand during caging (Gresley). Called Fallers in Lancashire. *See also* Chairs; Dogs; Cage seat.

Cage tail-chain (Scot.). A chain fastened to the bottom of the shaft cage to haul a car out of a short dip road. (Barrowman)

Cage-tender. *See* Cager, 1.

Cageway. A cage guide, or the part of a shaft containing the guides. (Standard)

Caging (No. Staff.). The operation of changing the tubs or cars on a cage. (Gresley)

Caida (Mex.). A fall of ground. (Dwight)

Caimán (Mex). 1. An oreshoot. 2. A Stillson wrench. (Dwight)

Cainozoic; Cenozoic. Containing recent forms of life: applied to the latest three divisions into which strata have been arranged with reference to the age of the fossils they include. It includes the Tertiary and Post-tertiary of the British geologists. (Century)

Cairn; Carn (Gaelic). A mound or heap of stones erected for a memorial or mark, as a sepulchral monument, or a landmark, or to indicate the site of a cache. (Standard)

Cairngorm. A yellow or smoky brown variety of quartz found at Cairngorm, Scotland. (Webster)

Caisson. A water-tight box or chamber within which submarine construction is carried on under great air pressure to keep the water out (Webster). Used also in excavating for foundations in the presence of great quantities of water.

Caisson disease. A disease frequently induced by remaining for some time in an atmosphere of high pressure, as in caissons, diving bells, etc. Characterized by neuralgic pains and paralytic symptoms (Webster). Also called Bends.

Caja (Mex.). 1. Case; box; water-jacket of furnace; housing of crusher; *C. chica*, furnace-tap jacket; *C. fundida*, *C. quemada*, a burnt-out furnace-jacket. (Dwight)
2. (Sp.). Wall of a vein. 3. The inclosure of a deposit between walls, or between the roof and floor. (Halse)

Cajete (Mex.) - A masonry basin to receive the pulp from an arrastre. (Dwight)

Cajón (Peru). 1. Box; caisson. 2. Load of about 3 tons (variable in different localities). 3. Shoot. 4. Drain. 5. *C. del tiro*, shaft-compartment. (Dwight)
6. *C. de granzas* (Mex.), the pit to receive the crushed ore. 7. *C. inclinado* (Sp.). A buddle; an inclined table. (Halse)
8. (Sp.) In the southwestern United States, a cañon or narrow gorge with steep sides; a box gorge. (Standard)

Cajonero. (Sp.). The man who receives, registers and distributes the mine cars at the shaft mouth. (Dwight)

Cake. 1. The solid residue left in a filter press after the solution has been drawn off. (Clennell)
2. *See* Cake of gold. 3. To form in a mass as when ore sinters together in roasting, or coal cakes together in coking. (Duryee)

Cake copper. *See* Tough cake.

Cake of gold. Gold formed into a compact mass (though not melted) by distillation of the mercury from amalgam. Also called Sponge gold.

Cakes of ore. Flat masses of ore. (Morine)

Caking coal. *See* Coking coal.

Cal (Mex.). Lime; *C. apagada*, slaked lime; *C. viva*, quick or unslacked lime; *C. en piedra*, limestone or chalk. (Halse)

Cal (Corn.). Wolframite; tungstate of iron and manganese (Whitney). Frequently associated with tin ore.

Cala (Sp.). Prospecting-pit (Dwight). *See also* Cata.

Calabashing (Nigeria). Panning metalliferous gravel with a calabash, or gourd. (Skinner)

Calabrote (Mex.). A rope of large diameter. (Dwight)

Calaite. The mineral turquois. (Humble)

Calamaco (Mex.). Large piece of rock, difficult to break up. (Dwight)

Calamin. To apply to (pottery) a wash made from the pigment calamine. (Standard)

Calamina (Sp.). Dry bone; smithsonite (Lucas). *See also* Calamine.

Calamine. 1. A commercial, mining and metallurgical term comprising the oxidized ores of zinc, as distinguished from the sulphide ores (blendes). Used also by mineralogists as the name of mineral species, American mineralogists commonly calling the hydrous silicate of zinc, $H_2O.2ZnO.SiO_2$, by this name, but inasmuch as British mineralogists call the anhydrous carbonate, $ZnCO_3$, by the same name, some authorities advocate discontinuance of the use of the name for distinct mineral species and the confinement of its use to a class of ores, which was the original use and still is the commercial and technical use. (W. R. Ingalls, Trans. A. I. M. E., vol. 25, p. 17.)
2. A special kind of so-called galvanized iron. Spelled also Kalamin. (Standard)

Calamine stone (Eng.). A carbonate of zinc (Roberts). More properly, Smithsonite.

Calamita (Sp.). 1. Loadstone. 2. A compass needle. 3. Siderite or spathic iron ore. (Halse)

Calamite. 1. An asparagus-green variety of tremolite. (Standard)

Calaverite. A telluride of gold and silver, (Au. Ag) Te_2. Variable in composition, but contains about 39.5 per cent gold and 3.1 per cent silver. (U. S. Geol. Surv.)

Calcaire (Fr.). Limestone. (Standard)

Calcaire grossier (Fr.). An extensive coarse limestone stratum, or rather series of strata, found in the Paris Basin, belonging to the Eocene series. (Comstock)

Calcaphanite. A variety of diabase, with small kernels of calcium carbonate embedded in the green ground mass. (Webster)

Calcar. 1. Kind of oven, or reverberatory furnace used in the manufacture of glass for calcination of the batch into a frit. 2. An annealing arch or oven. (Webster)

Calcar (Mex.). To make a tracing of a drawing. (Dwight)

Calcarenite. A name suggested by A. W. Grabau for a "limestone or dolonite composed of coral or shell-sand or of calcic sand derived from the erosion of older limestones." The name is from Latin for lime and sand. (Kemp)

Calcáreo (Mex.). Calcareous. (Dwight)

Calcareous. Consisting of or containing carbonate of calcium. (Webster)

Calcareous grits. Sandy beds, intermixed with calcareous matter. (Hitchcock)

Calcareous sandstone. A sandstone containing a considerable proportion of calcium carbonate. (Bowles)

Calcareous spar. Crystallized carbonate of calcium. *See also* Calcite.

Calcareous tufa. A spongy, porous or vesicular deposit of calcium carbonate. When the carbonate of calcium is deposited in a solid form it is called travertine or calc-sinter. Stalactites and stalagmites are of this nature. (Roy. Com.)

Calcarone (Italy). A kiln used in Sicily in which sulphur is separated from the crude ore by heat. (Standard)

Calcedonia (Mex.). Chalcedony. (Dwight)

Calcedony. *See* Chalcedony.

Calcic. Of, pertaining to, or containing calcium. Said especially of minerals, particularly feldspars, of which calcium is an important constituent, and of igneous rocks which are characterized by the presence of such minerals. (La Forge)

Calciferous. Bearing, producing, or containing, calcite, or carbonate of calcium. (Webster)

Calcify. To make or become hard or stony by the deposit of calcium salts. (Standard)

Calcigenous. Forming a calx: said of certain metals. (Standard)

Calcilutite. A name suggested by A. W. Grabau for a limestone or dolomite made up of calcareous rock flour, the composition of which is typically nonsiliceous, though many calcilutites have an intermixture of clayey material. The word is from the Latin for lime and mud. (Kemp)

Calcin (Mex.). A roasting-furnace. (Dwight)

Calcina (Sp.). Concrete. (Halse)

Calcinable. Capable of being calcined or reduced to a friable state by the action of fire. (Century)

Calcinar (Mex.). To calcine or roast. (Dwight)

Calcination. The reduction of ore or other material to a calx or friable condition by the action of fire (Hitchcock). *See also* Calcine.

Calcinatory. *See* Calciner.

Calcine. To expose to heat, with or without oxidation; to roast. Applied to ores for the removal of water and sulphur, and the disintegration of the mass; to limestone for the expulsion of its carbon dioxide; etc. (Raymond)

Calciner. A furnace or kiln for roasting. (Raymond)

Calcining furnace. A furnace used for roasting ore in order to drive off certain impurities. (C. and M. M. P.) Also called Calciner.

Calcio (Sp.). Calcium. (Dwight)

Calciocelestite. A variety of celestite containing calcium. (Standard)

Calciovolborthite. A vanadate of copper and calcium. Contains about 38 per cent V_2O_5. (U. S. Geol. Surv.)

Calcirudite. A name suggested by A. W. Grabau for a "limestone or dolomite composed of broken or worn fragments of coral or shells or of limestone fragments, the interstices filled with calcite, sand, or mud, and with a calcareous cement." The word is derived from the Latin for lime and rubble. (Kemp)

Calcite. Hexagonal (rhombohedral) calcium carbonate, the more common form of $CaCO_3$. Contains 56 per cent lime, CaO. (U. S. Geol. Surv.)

Calcitrant. Refractory (Webster). Said of certain ores.

Calcium. A silver-white, rather soft metal of the alkaline earth group. Symbol, Ca; atomic weight, 40.07. Specific gravity, 1.56. (Webster)

Calcium carbide. A crystalline solid, CaC_2, colorless when pure, but often resembling gray limestone. It is made by heating lime and carbon together in the electric furnace, and is used for the generation of acetylene (Webster). Used in miners' lamps.

Calcium carbonate. A solid, $CaCO_3$, occurring in nature, as calcite, etc. (Dana)

Calcium chloride. A compound, $CaCl_2$, crystallizing usually with six molecules of water. (Webster)

Calcium fluoride. The compound, CaF_2, occurring in nature as fluorite. (Webster)

Calcium hydroxide. Slaked lime, $Ca(OH)_2$. (Webster)

Calcium phosphate. *See* Apatite.

Calcium sulphate. *See* Anhydrite; Gypsum.

Calco (Mex.). A tracing on cloth or paper. (Dwight)

Calcomalachite. A form of malachite containing calcite and gypsum; used as an ornamental stone. (Webster)

Calc-schist. A schistose rock, rich in calcite or dolomite, forming intermediate or transitional rock between the mica-schists and crystalline limestones. (Kemp)

Calc-sinter. Limestone deposited from springs and waters containing it; travertine (Hitchcock). Also called Calcareous tufa.

Calc-spar. A synonym for Calcite. (A. F. Rogers)

Calc-tufa (Corn.). A spongy or porous deposit of carbonate of calcium. *See also* Calcareous tufa.

Calculiform. Pebble-shaped. (Webster)

Caldear. 1. (Mex.). To glow with heat. (Dwight)
2. (Sp.). To heat a furnace; to weld. (Halse)

Caldera. 1. A very large crater produced by a gigantic explosion. 2. A crater produced by the fusion of the core of a volcano and the falling in of its summit. (Webster)
3. (Sp.). A kettle or caldron. *C. de vapor*, a steam boiler. 4. A winze. 5. The bottom of a shaft; a sump. (Halse)

Calderista; Calderero (Mex.). 1. A boiler-maker. (Dwight) 2. A blacksmith. (Halse)

Calderite. A variety of garnet. (Standard)

Caldron bottom (Eng.). The fossil root of a tree or fern lying on the roof of a seam of coal. It derives its name from the resemblance to the bottom of a caldron or pot. *See* Bell-mold; *also* Cauldron.

Cale (Mid.). A specified number of tubs taken into a working place during the shift. (Gresley)

Calecero (Mex.). A man who rides on hoisting-cage and gives the signals. (Dwight)

Caledonite. A green basic sulphate of lead and copper of uncertain composition. (U. S. Geol. Surv.)

Calentadura (Mex.). 1. The first bar of lead treated by a lead-refining furnace. (Dwight) 2. Putting a furnace into blast, or the first heating of a furnace (Halse). "Blowing-in" a furnace.

Calentar los cuerpos. 1. (Peru) The turning yellow of mercury in patio-amalgamation. (Dwight) 2. (Sp.) *C. un horno*, to blow in a furnace, or to put a furnace into blast. (Halse)

Calera (Mex.). Limekiln; calcining furnace. (Dwight)

Calero (Mex.). Lime burner; roaster-man. (Dwight)

Calesa (Mex.). Buckets for ore or water. (Dwight)

Caliber. The inner diameter or bore of a tube or pipe. (Nat. Tube Co.)

Calibrate. 1. To determine the caliber of, as the interior of a thermometer-tube. 2. To determine the relative value of, as different parts of an ordinary scale. (Century)

Calicanto. 1. (Mex.) Masonry work. 2. Auriferous conglomerate in Chuquibamba, Peru. (Dwight)

Calicata (Sp.). A digging or trial pit. (Raymond)

Calichal (Mex.). Second-class silver-ore (carrying from 150 to 1000 oz. per ton) (Dwight). At Pachuca, Hidalgo, the best or first-class ore separated in the mine, the second-class being known as *azogues*. (Halse)

Caliche. 1. (Chile and Peru). Impure native nitrate of soda. 2. (Uco, Peru) A thin layer of clayey soil capping auriferous veins. 3. (Chile) Whitish clay in the selvagé of veins. 4. (Mex.) Feldspar; a white clay. 5. (Mex.) A compact transition limestone. 6. (Colom.) A mineral vein recently discovered. 7. (Colom.) In placer mining, a bank composed of clay, sand and gravel. (Halse) 8. (Mex. and Southwest U. S.) Gravel, sand, or desert débris cemented by porous calcium carbonate; also the calcium carbonate itself.

Calichera (Chile). A deposit of *caliche*. (Halse)

Calicheros (Sp.). Lime burners. (Min. Jour.)

Calico marble. A local name for a Triassic conglomerate used in the columns of the old Chamber of Representatives in the Capitol at Washington. The source is Frederick County, Md. (Merrill)

Caliente (Mex.). Hot. The condition when mercury flours in amalgamation. (Dwight)

Calientes (Mex.). Silver ores, generally *colorados*, 1, with some sulphate of iron, the result of decomposition. (Halse)

Californian onyx. A dark amber-colored and brown aragonite, used in ornamentation. (Standard)

California pump. A rude pump made of a wooden box through which an endless belt with floats is operated; used for pumping water from shallow ground. (C. and M. M. P.)

Californite. A compact, massive vesuvianite. Used as an ornamental stone. (U. S. Geol. Surv.)

Caling (Mid.). Conveying tubs into the stalls out of turn—irregularly—so that each miner is not supplied with an equal number during the day. (Gresley)

Caliper; Calliper. An instrument with two legs, usually bent, fastened together with a hinge or spring, used for determining the thickness or diameter of objects, distance between surfaces, etc. (Webster)

Caliza; Piedra caliza (Mex.). Limestone. (Dwight)

Calk. 1. To drive tarred oakum into the seams between planks and fill with pitch. 2. A sharp-pointed piece of iron or steel projecting from the bottom of a horseshoe (Webster)

3. In metal working, to strike a chisel, or calking tool with a hammer, making a slight indentation along the seam. The effect of this is to force the edge of one plate hard against the other, and thus fill up any slight crevice between the plates which the rivets failed to close.

Calking tool; Calking iron. A blunt-ended chisel used in calking. *See also* Calk, 1 and 3.

Callainite. An apple- to emerald-green massive wax-like aluminum phosphate, $AlPO_4+2\frac{1}{2}H_2O$. (Dana)

Callais. A precious stone of greenish-blue color, probably turquoise, referred to by Pliny, 77 A. D. (Pliny History, Bk. 37, 151). Dana uses this is a synonym of callainite, an emerald-green, hydrated aluminum phosphate.

Callapos (Peru). Rude wooden steps at the mouth of a mine. (Dwight)

Callen; Kallen. Irony; especially used when a lode is rich in soft iron ocher. (Power)

Caller (No. of Eng.). A miner who goes round the villages about two hours before work commences, to call the men who examine the mine in the morning before the miners enter. (Gresley)

Calley-stone (York.). In coal mining, a kind of hard sandstone, more or less argillaceous (Century). *See also* Ganister, 3.

Calliard; Galliard (No. of Eng.). A hard, smooth, flinty grit-stone. (Gresley)

Callimus. Loose, stony matter found in the cavities of eaglestone. (Standard)

Calling course (Eng.). The time for the men to go to work (Bainbridge). *See also* Caller.

Callow. 1. The baring or cover of open workings. (Gresley) 2. The stratum of soil over the subsoil; the top or rubble bed of a quarry. 3. Low-lying marshy land. (Webster)

Callow cone. A conical settling tank with vertical central feed, peripheral overflow, annular launder to collect and convey away the overflow, and a spigot in the form of a gooseneck to discharge the tailings. (Liddell)

Callow process. A flotation process embodying the usual principles but in which agitation is secured by air forced into the pulp through the canvas-covered bottom of the cell. (Megraw, p. 18)

Callow screen. A classifying screen using the traveling-belt principle, the screen cloth forming the belt member. It passes over two drums, or pulleys, oversize being discharged while the belt travels under the drums. (Liddell)

Callys (Corn.). *See* Killas.

Calm; Caulm (Scot.). White or light colored blaes. (Barrowman). *See also* Blaes.

Calomel. Horn quicksilver. Mercurous chloride, Hg_2Cl_2, containing 85 per cent mercury. (Dana)

Calor de frío (Mex.). In the *patio* process, steam issuing from the ore mixture, especially in cold weather.

Calorie. The amount of heat required to raise the temperature of one gram of water one degree centigrade at or near the temperature of maximum density. Called Small calorie. (Webster)

Calorifics. The science of heat. The technics of artificial heating. (Webster)

Calorimeter. 1. Any apparatus for measuring the quantity of heat generated in a body or emitted by it, as by observing the quantity of a solid liquified, or of a liquid vaporized, or the amount of heat absorbed by a certain quantity of water, under given conditions. 2. The combined area of cross-section of smoke flues or passages, as in a locomotive boiler.

Calp (Ir.). A bluish-black to grayish-blue limestone found in Ireland. (Standard)

Cal viva (Sp.). Quicklime. (Min. Jour.)

Calx. 1. Lime. 2. The friable residue left when a metal or mineral has been subjected to calcination. Metallic calxes are now called oxides. 3. Broken and refuse glass returned to the pots. (Webster)

Calyx. A long cylindrical vessel of the same diameter as the core-barrel, which guides the bit, and receives the débris resulting from the action of the cutter. Its action is not unlike that of the diamond drill and necessitates the use of a powerful water flush. The cutter, which

takes the place of the diamond crown, has a number of long teeth which produce a chipping action when rotated by hollow flushing rods in the presence of a constant flow of water. Used in a system of oil-well drilling, originating in Australia. The great advantage of this system is that a core is extracted and preserved in a core-barrel and brought to the surface. (Mitzakis)

Calza. 1. (Mex.). A shim; liner. (Dwight)
2. A stone for scotching a wheel. 3. (Chile). A converter lining. 4. (Arg.) Lagging. (Halse)

Calzar (Mex.). To sheath or face with metal. To shim; to tamp. (Dwight)

Cam. A rotating piece, either noncircular or eccentric: used to convert rotary into reciprocating motion: often of irregular outline, and giving motion that is irregular in direction, rate, or time. (Standard) *In* stamp mills the cam projects *from* a revolving horizontal shaft and raises the stamp by catching the lower surface of the tappet or collar surrounding the rod on which the stamp-head is hung. The upper side of the cam has an easy curve, such as a parabola, so that when it strikes the tappet it may not jar it when the lifting movement begins. (Roy. Com.) Sometimes called Lifter or Wiper.

Cambay stone. A variety of carnelian from Cambay, India.

Cambiar (Mex.). To switch. (Dwight)

Cambiavia (Mex.). A turntable; a *man who* operates switch. (Dwight)

Cambio. 1. (Mex.). Switch. (Dwight)
2. (Sp.). Alteration, change. 3. *C. de naturaleza,* variation in the quantity and class of material forming a sedimentary deposit. *C. de potencia,* change in the thickness of a deposit. (Halse)

Cambrian. The oldest of the systems into which the Paleozoic stratified rocks are divided; also the corresponding geologic period. (La Forge)

Cameo. A gem carved in relief, from onyx, sardonyx, a shell or other material usually having layers of different colors. (Webster)

Cameo ware. Fine pottery with figures in relief of a different color from the ground, as jasper ware (Standard. *See also* Wedgewood ware.

Camino. 1. (Mex.) A road; a gallery or shaft in a mine used for general traffic. 2. *C. de hierro,* a railway; a railroad. (Halse)

Cammett table. *See* Wilfley table.

Camoien (Fr.). *See* Cameo.

Camón. 1. (Mex.) The iron tire of mill-wheel. (Dwight)
2. (Mex.) A section or segment of a crown wheel of a Chilean mill. 3. Pine boards forming the side of an arrastre. (Halse)

Camp. A mining town. (Weed)

Campaign. The period during which a furnace is continuously in operation. (Raymond)

Campan marble. A beautiful pale, yellowish-green stone mottled with white. A dark-green variety containing red blotches is known as Campan rouge. (Merrill)

Campana. 1. (Mex.) A bell. *See* Capellina; *also* Campanilla. (Dwight)
2. (Sp. Am.) Nonproductive ground. (Lucas)

Campanela (Mex.). An upper drill hole. (Dwight)

Campanero (Mex.). A bellman, or station tender. (Dwight)

Campanil (Sp.). Compact red hematite. (Halse)

Campanilla (Sp.). A bell-signaling apparatus. (Halse)

Camper (Scot.). Coal slightly altered by whin; dirty coal. (Barrowman)

Campero (Mex.). The foreman in charge of *Campos.* A miner working on tribute. (Dwight)

Campistas (Sp.). Tributers. (Min. Jour.)

Campo. 1. (Mex.) A limited lease of a small section of ground in a mine. 2. A mining camp. *See also* Real, 1. (Dwight)
3. (Braz.) Undulating table-land.
4. (Mex.) A mine-working in possession of *buscónes.* (Halse)

Camptonite. A name given by Rosenbusch to certain dike rocks at Campton, N. H., having in typical cases the mineralogical composition of diorites, *i. e.,* with dark-brown hornblende, plagioclase, magnetite, and more or less augite. They are often porphyritic in texture, and may even have a glassy groundmass. Without the microscope camptonites usually appear as dark basaltic rocks with a few shining crystals of hornblende or augite; their determination is essentially miscroscopic. (Kemp)

Campylite. A yellowish to brown variety of mimétite crystallizing in barrel-shaped forms. (Dana)

Cam shaft. In stamp milling, a strong horizontal revolving shaft to which a number of cams are attached in such a manner that no two of them shall strike the tappets at the same instant, distributing the weight to be lifted. (Winchell)

Camstone. 1. A compact, whitish limestone. 2. A bluish-white clay used for whitening purposes. (Standard)

Cañada (Sp.). A ravine, or small cañon. (Raymond)

Canadian pole system. A system of oil-well drilling differing from the American cable system, in that wooden rods screwed together are used instead of a rope. The Canadian pole is a useful all-round prospecting rig, and it is particularly suitable for regions where excessive caving makes it necessary to have some positive method of rotating the bit. (Mitzakis)

Canadol. A light petroleum ether of the specific gravity 0.650–0.700, which has been used for the production of local anesthesia by spraying, and as a solvent. (Bacon)

Canal. 1. (Mex.) Channel. Spout; *C. de humo*, a flue. 2. *C. del oro*, a gold-bearing channel. (Halse)

Canales (Sp.). Deposits of manganiferous oxide of iron, formed by filling crevices in limestone, and conformable to its stratification. (Halse)

Canalistas (Braz.). Gold dredging men who work in the channel. (Halse)

Canalón (Colom.). A ground sluice used in placer mining; a channel; a sluice. (Halse)

Canary ore. A yellow earthy argentiferous lead ore, generally pyromorphite, bindheimite, or massicot, more or less impure. (Power)

Canary stone. A somewhat rare yellow variety of carnelian. (Power)

Canasta (Mex.). A basket. (Dwight)

Canastillo (Mex.). A tramway-bucket. (Dwight)

Canch. 1. A part of a bed of stone worked by quarrying. (Raymond) 2. (No. of Eng.). That part of the roof of an underground roadway which has to be taken down, or of the floor to be broken up, in order to equalize the grade of the road. If above a seam, it is termed a Top canch; if below, a Bottom canch. Also spelled Caunche, Caunch. (Redmayne)

Cancha. 1. (Sp.) . A place for drying slimes or sorting ore. (Dwight) 2. (Peru). A mine dump. (Pforte)

Canchero (Peru). A person in charge of dumping and sorting of ores. (Dwight)

Cancrinite. A silicate and carbonate of sodium, calcium and aluminum $H_6Na_6Ca(NaCO_3)_2Al_6(SiO_4)_6$. (Dana) The name of the mineral is sometimes prefixed to the names of rocks containing it, as cancrinite syenite. (Kemp)

Cand (Corn.). Fluorspar, or fluorite occurring as a vein stone; called by the Derbyshire miners, Blue-john (Century). Also spelled Cann, Kann.

Candeias (Braz.). A miner's lamp. (Bensusan)

Candelero. 1. (Sp.). A candlestick. 2. (Peru). That part of drill hole remaining after blasting. 3. (Mex.). A piece of clay on which retort silver is laid for final heating. (Dwight)

Candil (Mex.). An oil lamp. (Dwight)

Candle coal. *See* Cannel coal.

Candle-power. Illuminating power, as of a lamp, or gas flame, reckoned in terms of the standard light of a candle (Webster). The British standard candle is defined as a sperm candle, that burns at the rate of 120 grains of sperm per hour. (Century)

Cañería (Sp.). A water pipe; an aqueduct. *C. de descarga*, water discharge. (Lucas)

Canfieldite. A metallic black-blue silver-tin-germanium sulphide ($Ag_8(Sn,GeS_6)$) that crystallizes in the isometric system. (Standard)

Canga (Braz.). A kind of auriferous glacial rock; in reality an iron breccia. Also applied to a brown porous conglomerate. (Halse)

Cangalla (Chile). Stolen ore. (Halse)

Cangalli (Bol.). A ferruginous quartz conglomerate. (Halse)

Cangáua (Sp.). A South American term for the volcanic mud of the Quiteuian Andes. (Page)

Cangrejeros (Colom.). Bunches or small pockets of gold occurring in veins. (Halse)

Canister. 1. (Aust.). A tin for holding blasting powder. 2. A hopper-shaped truck, from which coal is discharged into coke ovens. (Power)

Cank; Cankstone (Derb., Leic.). *See* Burr; Whin; Whinstone.

Canker. 1. (Eng.). The ocherous sediment in mine waters, being bicarbonate of iron precipitated by the action of the air. (Gresley)
2. Rust; verdigris or copper rust. 3. To rust, to corrode, to oxidize. (Webster)

Cann (Corn.). *See* Cand.

Cannel. *See* Cannel coal.

Cannel coal. A massive, noncaking, tough, clean, block coal of fine, even, compact grain, dull luster, commonly conchoidal cross fracture, having a typical low-fuel ratio, a high percentage of hydrogen, easy ignition, long yellow flame, black to brown greasy streak, and moderate ash, pulverulent in burning. It is essentially a rock derived by solidification and partial distillation or oxidation of water-laid deposits consisting of or containing large quantities of plant spores and pollen grains and more or less comminuted remains of low orders of water plants and animals. There may be admixed greater or less quantities of mud, woody or peaty material. (*U. S.* Geol. Surv. Bull. 659, p. 8) *This* word is derived from *Canwyl*, meaning a candle, from the readiness with which the coal ignites and gives off a steady flame. (Gresley)

Cannes marble. *See* Griotte marble.

Cannon-ball mill. A mill for grinding tough materials by attrition with cannon balls in a rotating drum or chamber (Standard). *See also* Ball mill.

Cannonier (Fr.) *See* Fireman.

Cannon shot. *See* Blown-out shot.

Canny (Corn.). Applied to lodes containing calcium carbonate and fluorspar (Power). *See* Cand.

Canoa (Braz.). A platform used in gold-washing. (Lock)

Cañon. 1. (Sp.) A valley, usually precipitous; a gorge (Raymond). Also spelled Canyon.
2. (Mex.). A mine-level drift or gallery. *C. de guia*, a drift along the vein. (Dwight)
3. (Sp.). An inclined flue; *C. de chimenea*, a flue or smokestack. (Halse)

Cant. 1. To slip or turn over to one side. (Gresley)
2. An inclination from a horizontal, vertical, or other given line; a slope or bevel; a tilt. (Webster)

Cant dog (Eng.). A handspike with a hook. A cant hook. (Century)

Canteen. A metal, wooden or leather vessel or flask of small capacity, used by soldiers, travelers, or workmen for carrying water or other liquid. (Webster)

Cantera. 1. (Sp.). A stone quarry. 2. (Mex.). An unstratified stone of volcanic origin, as an andesitic tuff, andesitic breccia; also a metamorphosed quartz-porphyry; a white-banded porphyry. 3. (Chile). A light, sandy tuff. 4. (Venez.) Small quartz veins which are detached from the principal veins. (Halse)

Cantero (Sp.). Stone mason; quarryman. (Min. Jour.)

Cantharid luster. A ceramic luster having green and blue irridescence like that of a Spanish fly. (Standard)

Cant hook. A wooden lever with a movable iron hook at the end used for canting or turning over logs. (Webster)

Cantle piece. A side piece in a cask head. *See* Cants. (Webster)

Canto (Mex.). The narrowest face of a timber. (Dwight)

Cantonite. A variety of covellite that occurs in cubes. (Standard)

Cants (Eng.). The pieces forming the ends of buckets of a waterwheel (C. and M. M. P.). *See also* Cantle piece.

Canturrón (Colom.). Oxide of manganese. (Halse)

Cañuela (Mex.). A fuse. (Dwight)

Canvas. Any strong cloth of cotton, hemp, or flax. A miner's name for brattice cloth.

Canvas tables. Inclined rectangular tables covered with canvas. The pulp, to which clear water is added if necessary, is evenly distributed across the upper margin. As it flows down, the concentrates settle in the corrugations of the canvas. After the meshes are filled, the pulp feed is stopped, the remaining quartz is washed off with clear water, and finally the concentrates removed (by hose or brooms). (Liddell)

Canyon. *See* Cañon.

Cap. 1. A piece of plank placed on top of a prop or stull. 2. The blue halo of ignited fire damp which shows above the yellow flame of a safety lamp when in air containing small quantities of fire damp. The percentage of fire damp can be roughly measured by the height of the cap. (Steel)
3. (So. Afr.) A mine when the vein matter is barren or when the vein is *pinched*, or contracted, is said to be "in cap." (Skinner)
4. Rock above coal or ore. *See also* Cap rock. 5. An attachment riveted on the end of a rope to which a chain may be fastened. (Gresley)
6. A fitting that goes over the end of a pipe, to close it, producing a dead end. (Nat. Tube Co.)
7. *See* Blasting cap.

Capa (Mex.). A flat deposit of ore or capping of lava, clay, etc.; stratum. (Dwight)

Capacho (Peru). A large leather bag having a capacity of 75 to 150 pounds of ore. (Pfordte)

Capacity of air compressor. The actual amount of air compressed and delivered, expressed in terms of free air at intake temperature and at the pressure of dry air at the suction. The capacity of an air compressor should be expressed in cubic feet per minute. (A. I. M. E., Bull. 140, p. lvii)

Caparrosa (Sp.). Copperas, the result of decomposition of pyrite, marcasite, or pyrrhotite (Halse). *See also* Alcaparrosa.

Capataz (Sp.). Foreman; overseer; captain. (Lucas)

Cap board. Same as Cap, 1. (Steel)

Cap crimper. *See* Crimper.

Cape diamond. A diamond of yellowish tinge. (Webster)

Capel; Kapel. 1. (Corn.). A composite stone of quartz, schorl, and hornblende (Raymond). *See* Caple.
2. A wall of a lode: so called by Cornish miners, and chiefly when the country closely adjacent to the lode itself has been more or less altered by those chemical agencies under the influence of which the latter was formed. Also called Cab. In the United States, Casing is sometimes used synonomously. (Century)

Capela (Mex.). A strap passing over a man's shoulders from handles of a wheelbarrow. (Dwight)

Capella (Sp.). A cupelling furnace. (Raymond)

Capellina (Mex.). In the *patio* process, the bell-shaped vessel, *campana*, of copper or iron beneath which the amalgam is distilled (Halse). *See* Piña, 1.

Capel lode (Corn.). A lode composed of hard unpromising felspathic minerals containing minute particles of chlorite (Power). *See also* Capel.

Cape ruby. A ruby-red garnet found associated with diamonds in the South African diamond mines. (Century)

Caperuza (Peru). An iron or earthen cylinder, placed over amalgam in distilling, so that the open lower end is in water, into which the condensing mercury drops. (Dwight)

Capes (Scot.). Movable sides and ends put on a hutch, wagon, or car to increase its capacity (Barrowman). *Compare* Bustle, 2.

Cap head (Eng.). A top for an air-box used in shaft sinking. (Bainbridge)

Capillarity. The peculiar action by which the surface of a liquid, where it is in contact with a solid (as in a capillary tube) is elevated or depressed. Capillarity depends on the relative attraction of the molecules of the liquid for each other and for those of the solid. *See also* Surface tension. (Webster)

Capillary. Resembling a hair; fine, minute; having a very small bore. (Webster)

Capillary pyrites. Same as Millerite. (Standard)

Capitação (Braz.). A poll tax, or a tax fixed according to the number of men employed in mines. (Halse)

Capitan; Capataz (Mex.). A mine captain; *C. de patio*, a surface boss. (Dwight)

Capitana (Peru). A hemispherical stone vessel, 2 feet in diameter, for washing pulp. (Halse)

Caple. (Corn.). A hard rock lining tin lodes (Duryee). *See also* Capel.

Caponazo (Mex.). A blow on the hand of the man holding a drill, due to fault of striker. (Dwight)

Caporal (Sp. Am.). One who supervises laborers; a boss. (Standard)

Capote. 1. (Mex.). The bell-shaped iron cover fitting over the *capellina*, in retorting to confine the heat. (Dwight)
2. (Colom.) A superficial layer of vegetal earth. (Halse)

Capotera (Colom.). A shallow placer. (Halse)

Cappeau furnace. A modification of the *Ropp* furnace for calcining sulphide ore. (Ingalls, p. 96)

Capped quartz. A variety of quartz containing thin layers of clay.

Capper. In brickmaking, the man who receives the filled molds as they come from a brick machine; a molder. (Standard)

Cappice (Aust.). A horizontal stick of timber or bar of steel used for supporting a weak roof (Power). A variation of Cap or Cap piece.

Cap piece. Same as Cap, 1. In Arkansas, usually a piece of wood split from a log. (Steel)

Capping. 1. The name given to a method by which the flow of a spouting oil well is stopped or restricted. When a very strong discharge of petroleum is expected, strong valves are attached to the casing, which permit the flow to be controlled, and in order to prevent these valves from being blown away, they are firmly anchored to the ground by means of long, heavy bolts. (Mitzakis)
2. The separation of a block of stone along the plane of the bedding (Bowles)
3. Sometimes used as a synonym for Over-burden. 4. *See* Cap, 1.

Cap pot. In glass making, a crucible having a lid or cap. (Century)

Cap rock. 1. Barren vein matter, or a pinch in a vein, supposed to overlie ore. (Raymond)
2. (Ark.) A hard layer of rock, usually sandstone, a short distance above a coal seam. (Steel)
3. The layer of rock next overlying ore, generally of barren vein material. (Webster)

Capsal. A capstan. (Standard)

Cap sill. The upper horizontal beam in the timber framing of a bridge, viaduct, etc. (Century)

Capstan. A vertical axle used for heavy hoisting, and worked by horizontal arms or bars. (C. and M. M. P.)

Capstan bar. One of the levers by which a capstan is worked. (Webster)

Capstone. In masonry, the uppermost or finishing stone of a structure. (Century)

Capsula (Mex.). A blasting cap. (Dwight)

Captain (Corn. and Wales). The official in immediate charge of the work in a mine (Raymond). *See* Mine captain.

Captain dresser (Eng.). A manager of ore-dressing plant. (Bainbridge)

Capuli (Peru). A kind of wood for mine timbering. (Halse)

Car. 1. A vehicle adapted to the rails of a railroad. A vehicle moved on wheels. (Webster)
2. A vehicle used for the conveyance of coal or ore along the gangways or haulage roads of a mine (C. and M. M. P.). Also called Mine car, Tram car, Tub, Wagon, and Mine wagon.

Cara (Sp.). The facet of a crystal. (Dwight)

Caracas (Colom.). Thin, hard layer of gray or reddish clay, between the bed rock and pay gravel. (Halse)

Caracol (Mex.). A curved, spiral, or shell-like structure exhibited by certain silver ores of San Dimas, Durango. (Halse)

Caracolite. A colorless, hydrous, lead-sodium chlorosulphate, perhaps $Pb(OH)Cl.Na_2SO_4$. Occurs as crystalline incrustations. (Dana)

Caracoly. An alloy of gold, silver, and copper used first by the Caribs in making ornaments. (Standard)

Carat. 1. A unit employed in weighing diamonds, and equal to 3⅛ troy grains (205 mg.). A carat-grain is one-fourth of a carat. The international metric carat (abbr. C. M.) of 200 mg. has (1913) been made the

standard in Great Britain, France, Germany, Holland, and the United States (Webster). 2. A term employed to distinguish the fineness of a gold alloy, and meaning one-twenty-fourth. Fine gold is 24-carat gold. Goldsmiths' standard is 22 carats fine, *i. e.*, contains 22 parts gold, 1 copper, and 1 silver. (Raymond)

Carat-goods. Parcels of diamonds which are of an average weight of about one carat each. (Century)

Carbenes. The components of the bitumen in petroleum, petroleum products, malthas, asphalt cements, and solid native bitumens, which are soluble in carbon disulphide, but insoluble in carbon tetrachloride. *See also* Asphaltene and Petrolene. (Bacon)

Carbide. 1. A binary compound of carbon with some other element (Webster). 2. A commercial term for calcium carbide used in miner's lamps.

Carbide of silicon. An artificial abrasive made by fusing coke, sand, salt and sawdust in electric furnaces. Discovered in an attempt to make artificial diamonds (Pike). *See* Carborundum .

Carbocoal. A pulverulent product obtained by distilling coal at a moderate temperature. It has but little resemblance to coke, but it ignites more readily, supposedly because of the occlusion of an extraordinary amount of oxygen. (Min. and Sci. Press, vol. 117, pp. 471 and 491.)

Carbodynamite. A form of dynamite in which fine charcoal is used as the absorbent. (Webster)

Carbohydrate. Any of a group of compounds, composed of carbon, hydrogen and oxygen and characterised by containing six or a multiple of six carbon atoms combined with hydrogen and oxygen in the proper proportion to form water. (Webster)

Carbolate. A salt of carbolic acid. (Webster)

Carbolic. Of, pertaining to, or derived from carbon and oil; of or pertaining to coal-tar oil. (Standard)

Carbolic acid. A white crystalline deliquescent compound, $C_6H_5.OH$, with a burning taste and odor resembling that of creosote. It is a caustic poison. (Standard)

Carbolite. A by-product in iron smelting, consisting of calcium-aluminum-silicon carbide, and used as a substitute for calcium carbide. (Standard)

Carbón (Mex.). 1. Charcoal. Also called Carbón de leña. 2. *C. de piedra*, mineral coal; *C. craso*, coking coal; *C. de gas*, gas coal; *C. pardo*, lignite or brown coal; *C. seco*, noncoking coal. 3. Graphite. (Halse)

Carbon. An elementary substance occurring native as the diamond and also as graphite or black lead and forming a constituent of coal, petroleum, asphalt, limestone and other carbonates, and all organic compounds. Symbol, C, atomic weight, 12.0. Specific gravity, 1.7 to 3.6. (Webster)

Carbona (Corn.). An irregular deposit or impregnation of tin ore, found in connection with a tin lode. (Raymond)

Carbonaceous. Coaly, containing carbon or coal. Especially shale or rock containing small particles of carbon distributed throughout the whole mass. (Steel)

Carbonado (Braz.). A black or dark-colored diamond, occurring in small irregular rounded nodules. (Halse)

Carbonate. 1. A salt formed by the union of carbonic acid with a base. 2. Any ore containing a large proportion of lead carbonate. *See also* Carbonates, 1.

Carbonated springs. Springs of water, containing carbon dioxide gas. They are very common, especially in volcanic countries; and sometimes contain so much gas, that if a little sugar be thrown into the water it effervesces like soda water. (Comstock)

Carbonated stone. An artificial stone in the manufacture of which steam and carbon dioxide are used to hasten hardening. (Standard)

Carbonate of barium. *See* Witherite.

Carbonate of calcium. *See* Calcium carbonate; *also* Calcite.

Carbonate of strontium. *See* Strontianite.

Carbonates. 1. The common term in the West for ores containing a considerable proportion of carbonate of lead. They are sometimes earthy or ocherous (soft carbonates), sometimes granular and comparatively free from iron (sand carbonates), and sometimes compact (hard carbonates). Often they are rich in silver (Raymond). Salts of H_2CO_3.
2. (Eng.) Black, imperfectly crystallized form of diamond used for rock boring. The diamond is set in

a bit which, as it turns, cuts the rock in an annular form, producing cores (Gresley). *See also* Carbonado.

Carbonato (Sp.). Carbonate; *C. de hierro*, spathic iron. (Halse)

Carbon black. A name for lampblack.

Carbon dioxide. A heavy colorless irrespirable gas, CO_2, which extinguishes a flame. It is formed in mine explosions and mine fires and forms part of the afterdamp.

Carbon disulphide. A clear liquid, CS_2, of very disagreeable odor.

Carboncría (Sp.). 1. A coal yard. 2. A coal shed. 3. A coal mine. *See also* Hullera. (Halse)

Carbonero. 1. (Mex.). A coke or coal wheeler. (Dwight)
2. (Sp.). A coal miner. 3. A coal merchant. 4. A colliery or coal mine. *See also* Hullera. (Halse)

Carbonet. *See* Briquet.

Carbon flame. The characteristic white flame caused by burning carbon. It issues from the converter only when all the silicon has been removed from the molten iron. (Webster)

Carbonic acid gas. *See* Carbon dioxide.

Carbonic oxide gas. *See* Carbon monoxide.

Carboniferous. In the nomenclature of the U. S. Geological Survey, and in general usage as well, the youngest of the systems into which the Paleozoic stratified rocks are divided; also the corresponding period of geologic time. (La Forge)

Carbonite. 1. A native coke, occurring at the Edgehill mines, near Richmond, Va.; it is more compact than artificial coke and some varieties afford bitumen. (Bacon)
2. A permissible explosive.

Carbonization. The process of converting to carbon, by removing other ingredients, a substance containing carbon, as in the charring of wood or the natural formation of anthracite. (Raymond)

Carbonized. Converted into carbon. (Hitchcock)

Carbon monoxide. A colorless, odorless gas, CO. It is the product of incomplete combustion of carbon. It burns with a pale-blue flame forming CO_2. It is very poisonous to animals, since it combines with the haemoglobin of the blood, expelling oxygen (Webster). Also known as White damp.

Carbono (Sp.). The element carbon. (Dwight)

Carbon oil. A trade name for kerosene. (Bacon)

Carbonolite. Wadsworth's name for carbonaceous rocks. (Kemp)

Carbon spar. A name given to several mineral carbonates, as carbonate of magnesium, zinc, etc. (Century)

Carbon spot. A black spot in the body of a diamond. (Webster)

Carbon steel. Steel deriving its qualities from carbon chiefly, without the presence of other alloying elements (Webster). Ordinary steel, as distinguished from chrome steel, manganese steel, etc. (Standard) *See also* Simple steel. *Compare* Alloy steel.

Carbon tube. A cylindrical glass vessel used in the calorimetric determination of carbon in steel (Webster. *See also* Combustion tube.

Carborundum. A crystalline compound, SiC, consisting of silicon and carbon. It is produced in an electric furnace and used as an abrasive (Webster). Silicon carbide.

Carborundum machine. A machine provided with carborundum wheels designed to cut moldings, cornices, balusters, etc., from stone. (Bowles)

Carboy. A large globular glass bottle enclosed in a box or in wickerwork; used mainly for the transportation of corrosive acids and the like. (Standard)

Carbuncle. A gem of a deep-red color, inclining to scarlet, found chiefly in East Indies. When held up to the sun it looses its deep tinge and becomes the color of burning coal. Formerly believed to be capable of shining in darkness. A variety of garnet, though the name includes also the ruby and the spinel. (Century)

Carburet. A combination of carbon with a metal or other substance. A carbide. (Webster)

Carbureted hydrogen. Any of several gaseous compounds of carbon and hydrogen, some of which are the constituents of illuminating gas. (Webster) Light carbureted hydrogen is methane or marsh gas, CH_4. It is the chief constituent of fire damp.

Carburization. The process of imparting carbon, as in making cement steel. (Raymond)

Carburo (Mex.). Carbide. (Dwight)

Cárcamo (Sp.). 1. A drain or conduit for carrying slimes. 2. A drain in a mine. 3. (Mex.) A slime pit. 4. A penstock. (Halse)

Carcão (Port.). A matrix in which gold occurs. (Halse)

Cárcel. 1. (Sp.) The timber frame of a shaft. 2. (Mex.) Hitches or steps for timbers. (Halse)

Card concentrator. A table made of two planes having a flexible joint between them dividing the table into two nearly equal triangles, forming a diagonal line along which concentrates separate from the tailings. (Liddell)

Cardenilla (Mex.). Proustite; ruby silver. (Halse)

Cardenillo (Mex.). Verdigris. (Dwight)

Cardiglio marble (It.). A gray, clouded variety of marble obtained for ornamental purposes from the Island of Corsica. (Page)

Cardinal points. The four principal points of the compass, as North, South, East, and West. (Webster)

Car dumper. A mechanical device for tilting a railroad hopper or gondola car over sidewise and emptying its contents. (Wellcox)

Carena (Sp.). An upright stanchion for supporting machinery. (Min. Jour.)

Carga. 1. (Mex.) A charge, as for a furnace. A mule load, generally of 300 lbs. Avoir., but variable in different places. *C. de arrastre*, a charge for an arrastre; usually about 200 lbs. Avoir. (Dwight) 2. *C. real*, a land tax. 3. (Colom.) Stones, pebbles, and gravel occurring in placers. 4. (Peru) Overburden of a placer mine. (Halse)

Cargada (Colom.). A placer containing many large stones. (Halse)

Cargador (Mex.). One who feeds a furnace; an ore carrier; a porter. (Dwight)

Cargadora (Sp. Am.). 1. The first washing trough (Lucas). 2. A charging vat (Halse). *See also* Tina.

Cargar (Mex.). To charge a furnace (Dwight). To feed a mill.

Cargo (Peru). The first portion of mercury added to an amalgamation charge. (Dwight)

Carguero. 1. (Mex.) A charger for a furnace. (Dwight) 2. (Colom.) Stones, pebbles, etc., taken from placer workings in order to extract the gold. (Halse)

Car haul. An endless chain or cable arranged to haul the cars automatically up a slope, from the top of which the cars may travel by gravity. (Steel)

Carinate fold. In geology, an isoclinal fold (Standard). *See also* Isoclinal.

Carinthian furnace. 1. A small reverberatory furnace with inclined hearth, in which lead ore is treated by roasting and reaction, wood being the usual fuel. (Raymond) 2. A zinc-distillation furnace with small vertical retorts. (Ingalls, p. 393.)

Carinthian process (sometimes spelled Corinthian). A metallurgical method for treating lead ore, the characteristics of which are: The smallness of the charge, the slow roasting, so that for every part of lead sulphide one part of sulphate and at least two of oxide are formed, the low temperature at which all of the operations are carried on, and the aim to extract all the lead in the reverberatory. The hearth is inclined toward the flue and the lead is collected outside of the furnace. (Hofman, p. 88)

Carlsbad twin; Karlsbad. A twin occurring in the monoclinic system with the vertical axis as the twinning axis. (Dana)

Carmeloite. A name given by A. C. Lawson to a group of eruptive rocks at Carmelo Bay, Calif., which are intermediate between the basalts and andesites. They range in silica from 52 to 60 per cent, have augite and plagioclase for phenocrysts; and a peculiar, orthorhombic, hydrated silicate of iron, lime, magnesia, and soda, which is a secondary mineral after some original, probably olivine. The secondary mineral has been called Iddingsite. (Kemp)

Carmichel-Bradford process. *See* Blast-roasting.

Carmin (Sp. Am.). Ore containing a large amount of oxide or carbonate of iron (Lucas). Colorados; gossan.

Carminite. A carmine to tile-red lead-iron-arsenate, perhaps $Pb_3As_2O_8 \cdot 10FeAsO_4$. Found in clusters of fine needles; also in spheroidal forms. (Dana)

Carnallite. A massive, granular, greasy, milk-white, soluble, hydrous, magnesium-potassium chloride, $KMgCl_3.6H_2O$, crystalizing in the orthorhombic system. (Dana)

Carne de vaca (Peru). Coarse-grained galena, generally mixed with gray copper-ore. (Dwight)

Carnelian. One of the varieties of chalcedony originally only the red, but now (1890) of any color (Roy. Com.). Also called Cambay stone, from that locality in India.

Carnotite. A canary-yellow mineral, somewhat variable in composition, containing uranium and vanadium, with either or both lime and potash. Is ordinarily a mixture of true *carnotite* $2UO_3.V_2O_5.K_2O+xH_2O$, and *tuyamunite*, $2UO_3.V_2O_5.CaO+xH_2O$. *Is* radioactive and is used as a source of radium. (U. S. Geol. Surv.)

Carnot's cycle. An ideal heat-engine cycle in which the working fluid goes through the four following successive operations. (a) Isothermal expansion to a desired point; (b) adiabatic expansion to a desired point; (c) isothermal compression to such a point that (d) adiabatic compression brings it back to its initial state. (Webster)

Carnot's function. A relation between the amount of heat given off by a source of heat, and the work which can be done by it. (Webster)

Carombé (Braz.). In placer mining, a shallow wooden box for carrying gravel, and also for use in draining levels. (Halse)

Carpet. A bituminous surface of appreciable thickness, generally formed on top of a roadway by the aplication of one or more coats of bituminous material with gravel, sand, or stone chips added (Bacon). Also called Blanket.

Carpintero (Sp.). A carpenter. (Min. Jour.)

Carquaise. An annealing arch for plate glass. (Standard)

Carrack (Eng.). *See* Capel.

Carrana (Peru). Light rawhide shovel for throwing *taquia* into a furnace. (Dwight)

Carranchó (Colóm.). 1. Decomposed country rock; generally granite, carrying auriferous pyrite. 2. Soft, shaly or schistose country rock in which the veins are unproductive. (Halse)

Carrara marble. A general name given to all the marbles quarried near Carrara, Italy. The prevailing colors are white to bluish, or white with blue veins; a fine grade of statuary marble is here included. (Merrill)

Carrascal (Mex.). Honey-combed quartz, generally barren. (Dwight)

Carrefra (Sp.). A quarry. (Standard)

Carrera (Mex.). A stroke, as of a piston. (Dwight)

Carrero (Mex.). A charge-wheeler; a trammer. (Dwight)

Carreta (Sp.) A wagon, cart, or wheelbarrow. (Halse)

Carretero (Sp.). A trammer. (Lucas)

Carretilla; Carrillo de mano (Sp.). A wheelbarrow. (Min. Jour.)

Carriage (Eng.). *See* Slope cage; *also* Carrigal.

Car rider. A brakeman or laborer employed to ride on car to the dumper, or on cars pushed from cradle, to apply brake and prevent hard bumping (Willcox). A blast furnace term.

Carrier. A catalytic by whose agency a transfer of some element or group is effected from one compound to another. (Webster)

Carrigal (Scot.). A wheeled bogie or platform for the conveyance of coal cars or tubs, in a level position, on a highly-inclined roadway. (Barrowman)

Carrileros (Sp.). Ore carriers. (Min. Jour.)

Carrillo (Sp.). 1. A small cart. 2. *C. de mano*, a wheelbarrow. 3. A pulley block. (Halse)

Carrizo (Mex.). A small hole in rock for a wooden plug. *See also* Chocolón. (Dwight)

Carro (Mex.). A charging buggy; mine car. (Dwight)

Carrot (Eng.). A solid cylindrical specimen or core cut in a borehole. (Gresley)

Carry. 1. (Scot.) The thickness of roof rock taken down in working a seam. 2. The thickness of seam which can be conveniently taken down at one working. (Barrowman)

Carrying gate (Derb.). The main haulage road in a mine. (Hooson)

Carse. A Scottish term applied to the flat lands in valleys. (St. John)

Cart. 1. (Scot.) A measure of 12 cwt. of screened coal (but in practice varying from 12 to 15 cwts.), by which miners were formerly paid. (Barrowman)
2. (Som., S. Wales) A tram with or without wheels for conveying coal underground in thin seams. (Gresley)

Carting (Som.). Hauling coal underground in thin seams. (Gresley)

Cartographic. Pertaining to a map. In geology a cartographic unit is a rock or group of rocks that is shown on a geologic map by a single color or pattern. (Ransome)

Carton. A pasteboard box containing high explosives, blasting-caps, or electric blasting caps, a number of which are packed in a wooden case for shipment. (Du Pont)

Cartridge 1. A cylindrical, waterproof, paper shell, filled with high explosive and closed at both ends (Du Pont). Used in blasting.
2. Short cylinders (about 4 inches long and 2½ inches in diameter) of highly compressed caustic lime made with a groove along the side, used in breaking down coal. *See also* Lime cartridge. (Gresley)

Cartridge pin. A round stick of wood on which the paper tube for the blasting cartridge is formed. (Greene)

Car trimmer. A person who adjusts the load in a railroad or mine car. (Steel)

Cart trade (Som.). *See* Land sale.

Cartucho (Mex.). Explosive cartridge. (Dwight)

Carving (Leic.). 1. A wedge-shaped vertical cut or cutting at the side of a stall. 2. An airway between the solid and a pack wall. (Gresley)

Casa (Sp.). House; *C. de fundición*, a smeltery; *C. de moneda*, a mint. (Halse)

Casar metales (Peru). To mix ores for amalgamation or smelting. (Dwight)

Cascajal (Sp.). A gravel pit. (Crofutt)

Cascajero (Colom.). An alluvial mine already worked but which still contains gold. (Halse)

Cascajo. 1. (Mex.) Gravel; waste rock; oxidized free-milling ore. (Dwight)
2. (Peru) A large pocket of ore containing native silver in quartz mixed with yellow ocherous clay. (Halse)

Cascalho (Braz.). 1. Coarse, gold-bearing gravel and sand and subangular rocks embedded in a ferruginous clay. 2. A mixture of clay and quartzose gravel found in river beds, and containing diamonds. (Halse)

Cáscara (Spain). Copper precipitate obtained from mine water; cement copper. (Lucas)

Case. 1. A small fissure, admitting water into the mine workings. (Raymond)
2. One of the frames, of four pieces of plank each, placed side by side to form a continuous lining in galleries run on loose earth. (Webster)
3. A wooden box in which dynamite, cartons of electric blasting caps, boxes of blasting caps or coils of fuse are shipped. (Du Pont)

Case book (No. of Eng.). A book kept at a colliery in which the name and description of every horse or pony which is off work for 24 hours, or longer, and the driver's name, is entered. (Gresley)

Cased tin (Eng.). Fine tin ore that is retreated by a gentle current of water flowing over the frame or table. (Hunt)

Case harden. To convert iron superficially into steel by partial cementation; as case-hardened steel. (Raymond)

Case hardening. A process of hardening (iron or steel) by carbonizing the surface, thus converting soft iron into steel or mild steel into hard steel to a depth depending on the length of treatment. This is commonly effected by cementation with charcoal or other carbonaceous material, but for a mere skin of steel a short treatment with fused potassium cyanide suffices. (Webster)

Case markings. The letters or figures stenciled or printed on the front of a case containing explosives indicating the size, weight, kind, strength, date, and place of manufacture. (Du Pont)

Cases of spar (Eng.). Intersecting veins of quartz. (Bainbridge)

Cash (Som.). Soft shale or bind in coal mines. (Gresley)

Cashy blaes (Scot.). Soft coaly blaes with little coherence. (Barrowman)

Casing. 1. (Corn.) A partition or brattice, made of casing plank, in a shaft. 2. (Pac.) Zones of material altered by vein action, and lying between the unaltered country rock and the vein (Raymond). *See also* Capel, Gouge, and Selvage. 3. Steel or iron tubing used to case an oil or gas well. (Nat. Tube Co.) 4. (Ohio) A local term applied to thin slabs of sandstone that split out between closely spaced joints. (Bowles)

Casing clamps. Instruments generally manufactured from wrought iron, and used for raising or lowering casing. They are made in two pieces held by heavy bolts, which fit into corresponding holes, on the sides of the clamps. In Canada, heavy wooden clamps are used instead of iron ones. (Mitzakis)

Casing cutters. Instruments used in oil fields for cutting casing prior to raising it to the surface, after the completion of a well. (Mitzakis)

Casing dog. In well boring, a fishing instrument provided with serrated pieces or dogs sliding on a wedge, to grip severed casing; also called Bull dog; Casing spear. (Nat. Tube Co.)

Casing elevators. In well-boring, a device consisting of two semi-circular clamps, with a chain link on either, that are hinged together at one end and secured by a latch at the other. Used for raising and lowering casing. *See also* Casing dog. (Nat. Tube Co.)

Casing fitting. A fitting threaded with a casing thread. (Nat. Tube Co.)

Casing head. 1. A fitting attached to the top of the casing of a well to separate oil and gas, to allow pumping, and cleaning out well, etc. It may have several lateral outlets, through which the flow of the oil can be controlled and led away to reservoirs by mean of pipes 2. In well boring, a heavy mass of iron screwed into the top of a string of casing to take the blows produced when driving the pipe. Also called Drive head. (Nat. Tube Co.)

Casing-head gas. Natural gas rich in oil vapors. So named as it is usually collected, or separated from the oil, at the casing head. Frequently called Combination gas or Wet gas.

Casing of a reef (Aust.). The abnormal vein stuff abutting on the solid reef (Duryee). *See also* Casing, 2.

Casing shoe. A circular steel instrument having a cutting edge, fixed to the bottom of each column of casing, to strengthen the casing, when driven into the ground. (Mitzakis)

Casing spear. An instrument used for recovering casing which has accidently fallen into the well. The "bull dog," which is the most simple form of casing spear, consists of a steel body tapered at the top, on which slide two steel segments with serrated edges. When lowered inside the casing to be recovered the steel segments are pushed upward, along the narrow part of the body, but when raised, the segments remain stationary, and the weight of the casing forces the thicker part to exercise a pressure on the segments forcing them outward. The greater the pull, the greater is the corresponding lateral pressure (Mitzakis). Also called Casing dog.

Casiterita (Mex.). The tin oxide, cassiterite. (Dwight)

Casquillo (Mex.). A blasting cap. (Dwight)

Cassel brown; Cassel earth. A brown pigment of varying permanence, consisting of impure lignite. (Webster)

Casserole. A small round dish with a handle; usually of porcelain. Used in chemical laboratories. (Webster)

Cassinite. A feldspar from Delaware county, Penn., containing several per cent of baryta. (Century)

Cassiterite. Tin oxide, SnO_2. Contains 79 per cent tin. The mineral from which practically all tin is obtained. (U. S. Geol. Surv.)

Cast. 1. The form of a fossil preserved in some substance which has filled the space left by the fossil. (Lowe) 2. To form in a particular shape by pouring molten metal into a mold and letting it harden. 3. To form by throwing up earth; to emit or give out. (Webster)

Cast-after-cast (Corn.). The throwing up of ore from one platform to another successively. *See also* Shambles. (Raymond)

Castanite. A chestnut-brown hydrous ferric sulphate, $Fe_2O_3 2SO_3 10H_2O$. (Dana)

Castaways. Sterile veinstone. (Power)

Castellano (Mex.). 1. A small furnace about 48 inches high, 10 inches square, used for lead smelting. Probably introduced by the Spaniards. (Dwight)
2. An ancient Spanish coin. (Halse)

Castellanos powder. A kind of blasting powder containing nitroglycerin and either nitrobenzene or a picrate, mixed with other materials. (Webster)

Casteth (Derb.). Said of a shaft when air issuing from it on a cool or frosty morning contains visible vapor. (Hooson)

Cast gate. In founding, the channel through which the metal is poured into a mold. (Century)

Casthole (Derb.). A prospect hole not exceeding about nine feet deep, the depth from which waste material may be thrown by hand. (Hooson)

Cast house. The building in which pigs or ingots are cast. (Raymond)

Castigar (Mex.). To smooth or plane surfaces of rocks or boards. (Dwight)

Castillite. An impure variety of bornite, containing zinc, lead, and silver sulphides. (Dana)

Castillo (Mex.). 1. The frame of a stamp mill. 2. A hoist; a pulley frame. (Halse)

Casting. Pouring or drawing fused metal from a blast furnace, cupola, crucible, converter, or ladle into molds. (Raymond)

Casting copper. Impure copper better suited for casting into various forms than for drawing into wires or rolling into sheets. (Weed)

Casting ladle. An iron ladle with handles, used to pour molten metal into a mold. (Century)

Casting over. A quarryman's term for an operation consisting of making a cut with a steam shovel, which, instead of loading the material on cars, moves it to one side, forming a long ridge. (Bowles)

Casting pit. The space in a foundry in which the molds are placed and the castings made. In the Bessemer and open-hearth steel works it is the space utilized for casting the molten steel into the cast-iron ingot-molds. (Century)

Casting plate. A casting table used in glass making. (Webster)

Cast-iron. Iron which has been cast, that is melted and run into a mold in which it assumes the desired form. Most cast-iron is pig iron which has been remelted in a cupola furnace. Iron made from ore by smelting in the blast furnace is, in fact, cast-iron and its properties are not altered by remelting, but it is commonly known as pig iron, or pig. (Century)

Castor. Same as Castorite.

Cast, or fusible porcelain. Same as Cryolite glass. Called also Hot-cast porcelain. (Standard)

Castorite. A transparent variety of pelalite that crystallizes in the monoclinic system. (Dana)

Cast scrap. Cast-iron scrap.

Cast steel. 1. Steel which has been rendered homogeneous by remelting in crucibles or pots. (Century)
2. Any malleable compound of iron produced by fusion, including both Bessemer and open-hearth steel, as well as crucible steel. (Standard)

Cast-weld. To weld by heating as if for casting, as to cast-weld rails. (Webster)

Caswellite. A bronze, copper-red, altered mica that is closely related to phlogopite. (Standard)

Cat; Catch earth (So. Staff.). A hard fire clay. (Gresley)

Cata. 1. (Sp.) A mine denounced, but unworked. (Raymond)
2. (Mex.) A prospect-hole, or pit. (Dwight)
3. (Braz.) A placer. (Halse)

Cataclasm. A breaking or rending asunder; a violent disruption. (Standard)

Cataclastic. Having a fragmental texture due to crushing during dynamic metamorphism: said of certain metamorphic rocks (La Forge). *Compare* Autoclastic.

Cataclinal. Extending in the direction of the dip: said of a valley. (Standard)

Cataclysm. 1. Any overwhelming flood of water; especially, the Noachian deluge. 2. Any violent and extensive subversion of the ordinary phenomena of nature; an extensive stratigraphic catastrophe. (Standard)

Cataclysmal. *See* Cataclysmic.

Cataclysmic. 1. Accompanied with violet disruption. (Lowe)
2. Pertaining to or of the nature of a cataclysm; characterized by a cataclysm or cataclysms. (Standard)

Cataeorte (Colom.). A prospecting trench; a ditch. (Halse)

Catalan forge. A forge, with a tuyère, for reducing iron ore, with charcoal, to a loup of wrought iron; a bloomery. *See also* Champlain forge. (Raymond)

Catalysis. Berzelius describes it as a decomposition and new combination produced among the proximate and elementary principles of one or more compounds by virtue of the mere presence of a substance or substances which do not of themselves enter into the reaction. (Ingalls, p. 194)

Catalytic. An agent employed in catalysis, as platinum black, aluminum chloride, etc. (Webster)

Cat and clay (Eng.). Straw and clay worked together, laid between laths in building mud walls. (Webster)

Catapleite. A light-yellow to yellowish-brown, hydrous silicate, $H_4(Na_2Ca)ZrSi_3O_{11}$, crystallizing in thin tabular hexagonal prisms. (Dana)

Catar; Catear. 1. (Sp.). To search for minerals. 2. (Colom.). To pan; to dolly. (Halse)

Cataziniite. A native alloy of iron and nickel, Fe_2Ni. (Standard)

Catastrophe. 1. In geology, a sudden, violent change in the physical conditions of the earth's surface; a cataclysm. (Standard)
2. In mining, a disaster in which many lives are lost or much property damaged, as by a mine fire, explosion, inrush of water, etc.

Catawbrite. A name given by O. Lieber to a rock in South Carolina that is an intimate mixture of talc and magnetite. (Kemp)

Cat bank (Eng.). An iron loop placed on the underside of the center of a flat corf bow (bucket handle), in which to insert the hook. (G. C. Greenwell)

Cat block. A pulley block.

Catchall. A tool for extracting broken implements from drilled wells. (Webster)

Catch basin. A reservoir to catch and retain surface drainage. (Webster)

Catch earth. *See* Cat.

Catcher. 1. (Eng.). A safety or disengaging hook for prevention of overwinding. 2. (Leic.). *See* Cage shut. 3. Strong beams in mine shafts to catch the rods of pumps in case of a breakdown. (Gresley)

Catches. 1. Catches or rests placed on shaft timbers, to hold the cage when it is brought to rest at the top, bottom, or any intermediate landing. Also called Latches, Chairs, Keeps or Dogs. 2. Stops fitted on a cage to prevent cars from running off. (Woodson)
3. (Mid.) Projecting blocks of wood attached to pump spears to prevent damage in case of a breakdown. (Gresley)

Catchment area. An intake area and all parts of the drainage basin which drain into it. (Meinzer)

Catchment basin. The entire area from which drainage is received by a reservoir, river, or the like. (Webster)

Catch pin (Eng.). A strong oak or iron pin fixed over and to the ends of the beam of a pumping engine, which, in the event of a broken spear, prevents damage to the top or bottom of the cylinder. *See also* Spring beams. (G. C. Greenwell)

Catch pit. A reservoir for saving tailings from reduction works (C. and M. M. P.). A catch basin.

Catch scaffold (Eng.). A platform in a shaft a few feet beneath a working scaffold to be used in case of accident. (Gresley)

Cat dirt (Derb.). 1. A hard fire clay. 2. Coal mixed with pyrite. 3. A kind of earthy scoria not unlike lava. (Min. Jour.)

Cateador (Mex.). Prospector (Dwight)

Catear (Sp.). To search for new mines. (Min. Jour.)

Cateo (Sp. Am.). Prospecting. (Halse)

Catero (Sp.). A prospector (Halse)

Cat face. A miner's term for glistening balls or nodules of pyrite in the face of coal.

Cat-faced block (N. Y. and Penn.). A bluestone quarryman's term for a mass of waste situated between two closely spaced open joints. (Bowles)

Cat gold. An early name for gold-colored mica. (Chester)

Cathead. 1. A small capstan. 2. A broad-bully hammer. *See also* Bully. (Raymond)
3. (Prov. Eng.) A nodule of ironstone containing fossils. (Standard)

Cathode. The negative terminal of an electric source, or more strictly, the electrode by which the current leaves the electrolyte on its way back to the source. (Webster)

Cat hole. A small hole dug in rock for the point of a tripod leg of a machine drill. (Gillette, p. 99)

Catlinite; Indian pipestone. A red clay found in southwestern Minnesota and formerly used by the Indians for making pipes. (U. S. Geol. Surv.)

Catoctin. A monadnock or residual mountain or ridge which preserves on its summit a remnant of an old peneplain. (La Forge)

Catogene. A general term for sedimentary rocks, since they were formed by deposition from above, as of suspended material. *Compare* Anogene; Hypogene.

Catrake. An hydraulic brake or controller of a Cornish pumping engine, first introduced by Boulton and Watt. (Gresley)

Catrines (Mex.). A general name given by Indians to foreigners, and includes Spaniards (*gachupines*), French (*gavachos*) and Germans, English, and North Americans (*gringos*). (Halse)

Cats (Scot.). Burnt clay used for tamping in wet strata. (Barrowman)

Cat salt. A granulated salt formed from the bittern or leach brine used for making hard soap. (Century)

Cat's brain. Sandstones traversed in every direction by little branching veins of calcite. (Power)

Cat's-eye. A greenish, chatoyant, variety of chrysoberyl. (Dana)

Cat's-head (Ireland). A nodule of hard gritstone in shale (Century). *Compare* Cathead, 3.

Cat silver. A name sometimes given to a variety of silvery mica. (Century)

Cat's quartz. 1. Same as Cat's-eye. 2. A variety of quartz containing fibers of asbestos. (Standard)

Cat-stane. 1. (Scot.). A conical cairn or monolith supposed to mark the locality of a battle. 2. One of the upright stones which supports the grate in a fireplace. (Century)

Cattermole process. A flotation process in which a quantity of oil, varying from 4 to 6 per cent and 2 per cent soap was added to a flowing pulp, to oil the sulphides and make them stick together, forming large and heavy granules. These granules are heavy enough to fall to the bottom and remain in a pulp current while the gangue is washed away. (Megraw, p. 15; T. J. Hoover, p. 10)

Catty. 1. An East Indian and Chinese weight of about 1⅓ pounds Avoir., or 604.8 grams. (Webster)
2. (Straits Set.). A gold weight which equals 2.9818 lbs. troy. (Lock)

Cauce (Mex.). A river channel; bed of a stream or river. (Dwight)

Cauf (No. of Eng). A coal bucket or basket. (C. and M. M. P.). *See also* Corf.

Cauk. 1. (Eng. Scot.). Chalk; limestone. 2. An English miner's term for barite, or heavy spar (Century). *See* Cawk, 1 and 2.

Cauld (Scot.). A dam in a river; a weir. (Century)

Cauldron; Cauldron bottoms (So. Wales). The fossil remains of the "casts" of the trunks of sigillaria that have remained vertical above or below the coal seam (C. and M. M. P.). *See* Bell-mold.

Caulk. A variation of Calk.

Caunch. *See* Canch.

Caunter-lode (Corn.). A vein coursing at a considerable angle to neighboring veins. (Raymond)

Caustic. Capable of destroying the texture of anything or eating away its substance by chemical action; burning; corrosive. (Webster)

Caustic ammonia. Ammonia as a gas or in solution.

Caustic lime. Calcium hydroxide, $Ca(OH)_2$, or slaked lime.

Caustic potash. Potassium hydroxide, KOH.

Caustic silver. Silver nitrate, $AgNO_3$.

Caustic soda. Sodium hyroxide, NaOH.

Cave. 1. A natural cavity, recess, chamber, or series of chambers and galleries beneath the surface of the earth, within a mountain, a ledge of rocks, etc.; sometimes a similar cavity artificially excavated. 2. Any hollow cavity. 3. A cellar or underground room. 4. The ash pit in a glass furnace. (Standard)
5. The partial or complete falling in of a mine. Called also Cave-in. (Weed)

Cave deposits. Irregular deposits of material in the caves generally found in limestone. (Duryée)

Cave earth. A deposit of sand, soil, etc., washed into caves. (Webster)

Cave hole. A depression at the surface, caused by a fall of roof in the mine. (Greene)

Cave-in. *See* Cave, 5.

Cavel. A stone mason's ax.

Cave man. One of a race of men of the early Stone Age, who dwelt largely in caves. (La Forge)

Cave pearl. A pearly concretion, in composition like true pearl, formed in limestone caves by the agency of water. (Webster)

Caver. (Derb.). 1. One who steals ore or coal at a mine. 2. An officer who guards a mine. (Standard)

Cavern. A large natural underground cavity or cave; a den; any cavity. (Standard)

Cavern limestone. Any limestone abounding in caverns, especially the Carboniferous limestone of Kentucky. (Webster)

Cavernous. Containing cavities or caverns, sometimes quite large. Most frequent in limestones and dolomites. (Roy. Com.)

Cavil. 1. (No. of Eng.). A lot, drawn quarterly by a miner for his working place in the mine. (Gresley)
2. To draw lots at stated periods, by miners to determine the places in which they will work for the following period. (Power)

Cavilling rules (No. of Eng.). Rules or by-laws in reference to cavils and wages. (Gresley)

Caving. 1. The falling in of the sides or top excavations. (Raymond)
2. A system of mining developed in the Lake Superior district. *See* Caving system.

Caving by raising. *See* Chute caving.

Caving system. A method of mining in which the ore, the support of a great block being removed, is allowed to cave or fall, and in falling is broken sufficiently to be handled; the overlying strata subsides as the ore is withdrawn. There are several varieties of the system. *See* Block caving; Top slicing and cover caving; Top slicing combined with ore caving.

Cawk. 1. (Eng.) Sulphate of barium; heavy spar. (Raymond)
2. (Scot.). Chalk; limestone (Standard). Also spelled Cauk.

Cayuse. An Indian pony. A common term in Western United States. (Webster)

Cazar (Mex.). To ram with a piece of timber. (Dwight)

Cazeador (Sp.). Amalgamator. (Dwight)

Cazo (Sp.). A caldron in which amalgamation is effected by heating; used in Mexico and South America (Raymond). Any large copper or iron vessel. (Dwight)

Cebar. 1. (Sp.). To melt rich ores, or lead bullion, etc., in the smelting furnace. To add small quantities of material, from time to time, to the bath in a furnace. Generally, to feed any kind of metallurgical machinery or process. (Dwight)
2. *C. el barreno*, to prime a drill hole. 3. *C. la bomba*, to prime a pump. (Halse)

Cebo (Sp.). 1. The second addition of mercury, to the *torta* in the *patio* process. 2. A charge for a smelting furnace. 3. Priming, as of gunpowder. 4. (Colom.) Calcium Carbonate deposited in veins. 5. (Mex.) *Metal de cebo*, very rich silver ore smelted in a refining furnace. (Halse)

Cedarite. A fossil resin resembling amber, somewhat widely distributed in the alluvium of the Saskatchewan River in Canada. *See also* Succinite. (Bacon)

Cedazo (Mex.). Screen or sieve. *See also* Criba. (Dwight)

Ceja (Mex.). In vanning with horn spoon or miner's pan, the heaviest streak or concentrate that appears at the edge. (Dwight)

Celasa (Mex.). A cage. (Dwight)

Celestite. Strontium sulphate, $SrSO_4$. (Dana)

Cell. A single jar or element of a voltaic battery. There are many types and varieties.

Cellar stone. Small, irregular, rock fragments. (Bowles)

Cellular pyrite. Marcasite. (Power)

Cement. 1. The material that binds together the particles of a fragmental rock. It is usually calcareous, siliceous, or ferruginous. 2. The word is also used in gold-mining regions to describe various consolidated, fragmental aggregates, such as breccia, conglomerate, and the like, that are auriferous. (Kemp) 3. A substance used in a soft pasty state to join stones or brick in a building, to cover floors, etc., which afterwards becomes hard like stone; especially a strong mortar made with lime or a calcined mixture of clay and limestone. *See also* Portland cement. (Webster) 4. A finely divided metal obtained by precipitation. 5. The substance in which iron is packed in the process of cementation. (Standard)

Cementation. 1. A process of causing a chemical change in a substance by heating it while embedded in a powdered mass of another substance, as in making steel by heating wrought iron in charcoal until it is carburized, or in making so-called malleable iron by heating cast iron in a bed of red hematite until it is partly decarburized. (Standard) 2. The process of obtaining a metal by precipitation from a solution, as copper from a solution of blue vitriol by means of metallic iron. (Webster) 3. The process by which sediments, or sands, are consolidated into hard rock. Used in oil-well practice.

Cementation-box. The box of wrought iron in which case hardening is effected. (Century)

Cement copper. Copper precipitated from solution. (Raymond)

Cement deposits. The Cambrian conglomerates occupying supposed old beaches or channels. Gold bearing in the Black Hills. (Ore Dep., p. 309)

Cement gold. Gold precipitated in fine particles from solution. (Raymond)

Cement gun. A mechanical apparatus for the application of cement to the walls or roof of a mine, or for the application of stucco to the walls of buildings.

Cementing furnace. A furnace used in the process of cementation. (Century)

Cementing material. *See* Cement, 1, 3 and 5.

Cementing oven. An oven used for the same purpose as a cementing furnace. (Century)

Cementite. Iron combined with carbon as it exists in steel before hardening. (Standard)

Cement mill. A mill for crushing and grinding cement stone; also a mill for grinding the cinder after it comes from the kiln.

Cemento (Sp.). 1. Hydraulic lime or cement. 2. In geology, the cementing material of a conglomerate or breccia. 3. A brown deposit obtained in the precipitation tank by the addition of iron sulphate in the chlorination process. (Halse)

Cement rock. An argillaceous limestone used in the manufacture of natural hydraulic cement. Contains lime, silica, and alumina in varying proportions, and usually more or less magnesia. (U. S. Geol. Surv.)

Cement silver. Silver precipitated from solution, usually by copper. (Raymond)

Cement steel. Steel made by cementation; blister steel. (Standard)

Cement stone; Cement rock. Any rock which is capable of furnishing cement when properly treated. (Century)

Cendrada. 1. (Mex.) The cupel-hearth of a furnace in which silver is refined or rich lead cupelled. Made of finely-pulverized clay or other absorbent earth, mixed with ashes of bone or wood. (Dwight) 2. (Sp.) Ashes or cinders at the bottom of a furnace, and valuable for use in other smelting operations. (Raymond) 3. (Chile) The crucible of a copper smelting furnace. (Halse)

Cendradilla (Mex.). A small reverbatory furnace for smelting rich silver ores in a rough way. Also called *Galeme.* (C. and M. M. P.)

Cenicero (Sp.). Ashpit; ash hole. (Halse)

Ceñido (Mex.). Narrowed. (Dwight)

Cenizas (Sp.). Ash; cinder; *C. de hueso,* bone ash. (Halse)

Cenozoic. The latest of the five eras into which geologic time, as recorded by the stratified rocks of the earth's crust, is divided; it extends from the close of the Mesozoic era to and including the present. Also the whole group of stratified rocks deposited during the Cenozoic era. The Cenozoic era includes the periods called Tertiary and Quaternary in the nomenclature of the U. S. Geological Survey; some European authorities divide it, on a different basis, into the Paleogene and Neogene periods, and still others extend the Tertiary period to include the whole. (La Forge)

Center country (Aust.). The rock between the limbs of a saddle reef. (Power)

Center cut. The bore holes, drilled to include a wedge-shaped piece of rock, and which are fired first in a heading, tunnel, drift, or other working place. (Du Pont). *See also* Center shot.

***Centering*; Centreing.** A substructure, usually of timber or planks, on which a masonry arch or vault is built, and on which it rests until complete and therefore self supporting. (Webster)

Center of gravity. That point in a body or system of bodies through which the resultant attraction of gravity acts when the body or system of bodies is in any position; that point from which the body can be suspended or poised in equilibrium in any position. (Webster)

Center of mass. A point in a body, or system of bodies, such that the sum of the moments of the component particles about any plane through the point equals zero. (Webster)

Center of symmetry. In crystallography, in general, the point in which the axes or planes of symmetry intersect; in the normal group of the triclinic system, which has neither planes nor axes of symmetry, the point with respect to which equivalent opposite faces are symmentrical. (La Forge)

Center shot. A shot in the center of of the face of a room or entry (Steel). Also called Center cut.

Centigrade. Consisting of a hundred divisions. The centigrade thermometer has zero, 0°, as the freezing point of water and 100° as the boiling point. To convert centigrade thermometer readings to Fahrenheit readings multiply the former by 1.8 and add 32°. (Goesel)

Centigram. A weight equal to one hundredth part of a gram, or 0.15432 of a grain. *See also* Gram. (Webster)

Centner (Ger.). A commercial hundred weight in several continental countries, now generally fixed at 50 kg. or 110.23 lbs. (Webster)

Centric. In geology, having the material more or less arranged either radially or concentrically around centers, a crystal often forming the center: said of rock texture. (Standard)

Centrifugal force. A force directed outward when any body is constrained to move in a curved path; flying away from the center. (Webster)

Centrifugal pump. A form of pump which displaces fluid by whirling it around and outwardly by vanes rotating rapidly in a closed case. (Webster)

Centripetal pump. A pump with a rotating mechanism that gathers a fluid at or near the circumference of radial tubes and discharges it at the axis. (Standard)

Centro (Mex.). Center. (Dwight)

Centroclinal. In geology, an uplift of strata which gives them a partial quaquaversal dip. (Standard)

Centrosphere. In geology, the central portion of the terrestrial globe. (Standard)

Centrosymmetrical. In mineralogy, having symmetry around a center, but without plane or axis of symmetry. (Standard)

Cepillo (Mex.). A brush; *C. chico*, a shaper; *C. grande*, a planer. (Dwight)

Cepo (Mex.). 1. A notch in which timber is fixed. (Dwight)
2. The cylindrical post in the bottom of an arrastre upon which the vertical post revolves. (Halse)

Ceramic. Of or pertaining to pottery (including porcelain and terra-cotta) or its manufacture, fictile art, or ceramics in general. (Standard)

Ceramics. 1. That department of plastic art which includes the production of all objects formed by molding, modeling, and baking clay, such as terra-cotta, and pottery in general; fictile art. 2. The objects so made. (Standard)

Ceramist. A person devoted to the ceramic art, whether as a manufacturer, a designer and decorator, or as a student or connoisseur. (Century)

Ceramites. A term used by M. E. Wadsworth to include all fictile ceramic minerals. (Power)

Cerargyrite; Horn silver. Silver chloride, AgCl. Contains 75 per cent silver. (U. S. Geol. Surv.)

Ceratophyre. *See* Keratophyre.

Cerca (Chile). Bed rock. Sometimes spelled *Circa.* (Halse)

Ceresine. A trade name for refined ozocerite. (Mitzakis)

Cerite. A hydrous silicate of cerium and allied metals occurring generally in brown masses. Hardness, 5.5; specific gravity, 4.86. *See also* Allanite. (Dana)

Cerium. A rare metallic element resembling iron in color and luster, but is soft, malleable and ductile. Symbol, Ce; atomic weight, 140.25. Specific gravity, 6.7. (Webster)

Cerium metals. A group of related rare earth metals including cerium, lanthanum, praseodymium, and neodymium. (Webster)

Cermak-Spirek furnace. An automatic reverberatory furnace of rectangular form divided into two sections by a longitudinal wall. Used for roasting zinc and quicksilver ores. (Ingalls, p. 125)

Cernidero (Colom.) The place where the screening and washing operation takes place in placer mines. (Halse)

Cernidor. 1. (Mex.). Moving screen; trommel. (Dwight)
2. (Colom.). A buddler. (Halse)

Cernidos (Peru). Small ore remaining on a ½ to ¾ in. screen. (Pfordte)

Cernir (Sp.) To screen or separate. (Lucas)

Ceroid. Waxlike. (Hitchcock)

Cerracho (Peru). Mercury that collects on the top of the furnace charge. (Halse)

Cerrazón (Colom.). A portion of a placer deposit abounding in large stones. (Halse)

Cerro. 1. (Sp.). A hill or mountain. (Raymond)
2. (Colom.). *Mina de cerro,* a placer mine near mountain tops or on high table-lands where water is scarce. (Halse)

Certain rent. Same as Dead rent.

Ceruleum. A blue pigment, consisting of protoxide of cobalt, mixed with stannic acid and sulphate of calcium.

Ceruse. A name sometimes applied to white lead. (Ure)

Cerusita (Mex.). Cerussite (Dwight)

Cerussite. Lead carbonate, $PbCO_3$. Contains 77.5 per cent lead. (Dana)

Cervantite. An orthorhombic antimony oxide, Sb_2O_4. Infusible before the blowpipe. (U. S. Geol. Surv.)

Cesio (Mex.). Cæsium. (Dwight)

Cesta. (Sp.). A basket; *C. de minero,* a miner's basket. (Halse)

Ceylonite; Ceylanite. A dark variety of spinel in which iron is present. From Ceylon. (Dana)

Chabazite. A hydrous silicate, essentially of calcium and aluminum. (Dana)

Chacra. 1. (Bol.). An inheritance of gold (Lock)
2. (Peru). A small tract of land owned by an Indian miner. 3. An Indian village. (Halse)

Chacuaco (Mex.) A cupel furnace with absorbent hearth. (Dwight)

Chacurruscar (Peru). To mix several kinds of ore. (Dwight)

Chad (Eng.). Gravel; small stones which form the bed of a river. (Century)

Chadacryst. An inclosed crystal; the smaller crystal of a poikilitic fabric. *See also* Oikocryst. (Iddings, p. 202)

Chadger (Derb.). Anything made fast to a hoisting rope by a noose, as a large rock or piece of ore that cannot be placed in a bucket. (Hooson)

Chafery. A forge fire for reheating. (From the Fr. *Chaufferie.*) (Raymond)

Chaffee work. A local term used in Colorado for annual labor on a mining claim. (Duryee)

Chafián (Mex.). An inclined winze; bevel. (Dwight)

Chain. 1. A unit of measurement used in surveying principally and equal to 66 feet. Called Gunter's chain. Usually divided into 100 links, each link being 7.92 in. long. 2. A series of links or rings, usually of metal, connected or fitted into one another. 3. A mechanical combination con-

sisting of two or more links. 4. A circuit as of a galvanic battery. 5. In chemistry, a number of atoms united serially. (Webster) 6. (or saw) The portion of the machine that does the cutting in the work of undercutting coal at the face of an entry. (Morris v. O'Gara Coal Co., 181 Illinois App., p. 312)

Chain-breast machine. A coal-cutting machine, so constructed that a series of cutting points attached to a circulating chain work their way for a certain distance under a seam; when the limit is reached, the machine is withdrawn and shifted to one side, where another cut is put in. (Power)

Chain-brow way. An underground inclined plane worked by an endless chain. (Gresley)

Chain grate. A feeding device for furnaces.

Chainman. 1. Either of the two men necessary to use a chain or tape in surveying. (Webster) 2. *See* Chain runner.

Chain pillar. A pillar left to protect the gangway and airway, and extending parallel to these passages. (Chance)

Chain road. An underground haulage way operated by an endless chain system. (Gresley)

Chain runner; Chain boy; Chain man (Scot.). A person in charge of, and who accompanies, cars, trips, or trains in mechanical haulage. (Barrowman)

Chain tongs. A pipe-fitter's tool; a lever with a serrated end provided with a chain to embrace the pipe. (Nat. Tube Co.)

Chainwall (Scott.). 1. A system of working by means of wide rooms and long narrow pillars, sometimes called Room and rance. 2. A long narrow strip of mineral left unworked, *e. g.*, along the low side of a level. (Barrowman)

Chairs. Movable supports for the cage arranged to hold it at the landing when desired. Also called Catches, Dogs, Keeps. (Steel)

Chalcanthite. A hydrous copper sulphate, $CuSO_4+5H_2O$. Blue vitriol. (U. S. Geol. Surv.)

Chalcedony. A transparent or more generally translucent cryptocrystalline quartz. It often lines or fills cavities in rocks. (U. S. Geol. Surv.)

Chalchihuitl (Mex.). Any green precious stone (Dwight). According to G. F. Kunz, the precious chalchihuitl is jadeite. Also spelled *chalchiguite* and *chalchuhuites*.

Chalchuite. A bluish-green turquoise found in New Mexico, and, according to W. P. Blake, the same as Chalchihuitl. (Dana)

Chalcites. 1. A term used by M. E. Wadsworth to include lime, mortar, cement, etc., used as building materials. (Powe.) 2. A decomposition product of either iron or copper pyrites, hence described as iron sulphate (green vitriol), copper sulphate (blue vitriol), or iron oxide (colcother). (Standard)

Chalcocite. A copper sulphide, Cu_2S. Contains 79.8 per cent copper. Copper glance. (U. S. Geol. Surv.) The mineral is the characteristic and most important product of the downward enrichment of copper ores and the chief source of copper in the Ray and Miami (Ariz.) districts. (Ransome)

Chalcodite. A scaly mica-like bronze colored variety of stilpnomelane. (Dana)

Chalcomenite. A hydrous cupric selenite, $CuSeO_3+2H_2O$. Occurs in small blue monoclinic crystals. (Dana)

Chalcomorphite. A vitreous hydrous calcium-aluminum silicate. (Standard)

Chalcophanite; Hydrofranklinite. A hydrous manganese-zinc oxide $(Mn,Zn)O.2MnO_2.2H_2O$. (U. S. Geol. Surv.)

Chalcophyllite. A highly basic arsenate of copper, $7CuO.As_2O_5.14H_2O$, of various shades of green, occurring in tabular crystals or foliated masses. (Dana)

Chalcopirita (Mex.). Chalcopyrite. (Dwight)

Chalcopyrite. A sulphide of copper and iron, $CuFeS_2$. Contains 34.5 per cent copper. Copper pyrites, yellow copper ore. (U. S. Geol. Surv.)

Chalcopyrrhotite. A brownish, brass-yellow iron-copper sulphide, Fe_4CuS_5. (Standard)

Chalcosiderite. A light siskin-green hydrous copper-iron, phosphate, $CuO.3Fe_2O_3.2P_2O_5.8H_2O$. Occurs in sheaf-like crystalline groups as in crustations. (Dana)

Chalcosina (Mex.). Sulphide of copper; chalcocite. (Dwight)

Chalcostibite. A lead-gray copper-antimony sulphide, $Cu_2S.Sb_2S_3$. Called also Wolfsbergite. (Dana)

Chalcotrichite. A variety of cuprite in which the crystals are slender and hair-like. (Ransome)

Chalder (Scot.). A measure of weight. The Perth chalder was 5 tons, the River Forth chalder 80 cwts., the Hurlet chalder 2 tons (Barrowman).

Chalder wagon (No. of Eng.). *See* Chaldron.

Chaldron. Thirty-six bushels. In Newcastle 53 hundredweight avoirdupois. Chaldron wagons, containing this quantity, convey the coal from the mine to the place of shipment. (Raymond)

Chalk. 1. A fine-grained, soft, white, friable variety of limestone composed of the shells of various marine animals. (La Forge)
2. To mark with chalk. (Webster)

Chalking deal (Eng.). A flat board upon which is kept an account of the work done by the miners in a certain district (G. C. Greenwell). A bulletin board.

Chalking on (No. of Eng.). Keeping an account of the number of tubs (cars) sent out of a stall or room. (Gresley)

Chalupa (Mex.). A hoist; a skip, (Halse)

Chalybeate. Impregnated with salts of iron. (Webster)

Chalybite. *See* Siderite.

Chamba (Colom.). A pit or trench, (Halse)

Chamber. 1. *See* Breast; Room; Stall. 2. *See* Springing. 3. A body of ore with definite boundaries apparently filling a preexisting cavern. 4. A powder room in mine. (Webster)

Chamber and pillar (Penn.). *See* Breast and pillar.

Chamber-and-pillar system. *See* Sublevel stoping.

Chamber deposit. A cave filled with mineral (Power). *See also* Chamber, 3.

Chamber dust. *See* Fluedust.

Chambered lode. So called when a portion of the wall of a lode is fissured and filled with ore (Power). *See also* Chamber, 3.

Chambered vein. A mineral vein filling large areas of space in ruptured rocks. (Standard). A synonym for Stockwork and applied to mercury deposits at New Almaden (Ore Dep., p. 425). *See also* Chambered lode.

Chambering. *See* Springing.

Chamber kiln. A brick or tile kiln having chambers or compartments, sometimes so arranged that they can be heated successively. (Century)

Chamburgo (Colom.). A dyke or dam for retaining water at placer mines. (Halse)

Chamfer. 1. A small groove or furrow. 2. To cut at an angle or bevel. (Webster)

Chamois. A soft, pliant leather prepared originally from the skin of the chamois, but now also from the skin of a goat or sheep (Webster). Used for separating excess mercury from gold amalgam.

Chamosite; Chamoisite. A compact or oölitic greenish-gray to black hydrous aluminum silicate. Contains iron (FeO) with but little MgO. (Dana)

Chamotte. 1. (Fr.). Burned clay used by zinc smelters. (Ingalls, p. 228)
2. The refractory portion of a mixture used in the manufacture of firebrick, composed of calcined clay or of reground bricks. (Standard)

Champa (Peru). Turf. (Halse)

Champion lode. The main vein as distinguished from branches (Raymond). The term is of Cornish origin, and is little used in the United States. Also called Mother lode; Master lode. (Century)

Champlain forge; American forge. A forge for the direct production of wrought iron, generally used in the United States instead of the Catalan forge, from which it differs in using only finely-crushed ore and in working continuously. (Raymond)

Chamuscar (Peru). A superficial roasting or calcination, to facilitate the grinding of ore. (Dwight)

Chanca (Peru and Chile). Ore sorting and spalling. (Halse)

Chancadora (Sp.). Ore breaker. (Lucas)

Chancados (Peru). Ores spalled to a uniform size. (Pfordte)

Chancadura (Chile). Crushing with a rock breaker. (Halse)

Chancar (Peru and Chile). To cob ores. (Halse)

Chance. 1. In coal mining: The opportunity a shot has to break the coal. 2. The opportunity to put in a shot in a good position. (Steel)

Chance-Claus process. An industrial process for recovering sulphur from waste containing sulphides. It comprises two steps: (a) Treatment of sulphide with carbon dioxide, forming H_2S, and (b) oxidation of H_2S to water and sulphur by air in the presence of a catalytic, as ferric oxide. (Webster)

Chance measure (Eng.). Any seam or bed of coal or other rock occupying an unusual or foreign position in the strata. (Gresley)

Change day. The day when a gang of miners is transferred from day shift to night shift, or the reverse. (Weed)

Change house. A special building at mines or other works where laborers may wash, or change their clothes. Also called Dry house, Changing house, Moorhouse.

Changer and grather (No. of Eng.). A man whose duty it is to keep the pump buckets and clacks in working order about a colliery. (Gresley)

Changing bronze. The process of changing tuyères, plates, monkey, etc., at blast furnaces. (Willcox)

Changing house (Corn.). *See* Change house.

Chaigkul (Sumatra). A miner's hammer. (Lock)

Channel. 1. The deeper part of a river, harbor or strait where the current flows. 2. A closed course or conduit through which anything flows, as a tube, or duct; a gutter or trough. 3. Gravel—from being the material of which the river bed is composed. 4. In metallurgy, a sow or runner. 5. A cut along the line where rock or stone is to be split (Webster).

Channel bed (Scot.). A bed of gravel. (Barrowman)

Channeler. A machine for cutting stone in rock excavation where smooth sides are desired (Gillette, p. 551). A channeling machine.

Channeling machine. *See* Channeler.

Chanos (Chile). Pieces of metallic iron or copper, reduced in blast furnaces, and which solidify in the forehearth. (Halse)

Chanquires (Peru). Ore sorters. (Halse)

Chap. 1. (Scot.) A customary and rough mode of judging, by sound, of the thickness of coal between two working places, by knocking with a hammer on the solid coal. 2. To examine the face of the coal, etc., for the sake of safety, by knocking on it lightly. (Gresley)
3. A blow, rap, or knock. (Webster)

Chapa (Mex.). 1. A metal plate. 2. A lock. 3. Foliated structure. (Dwight)

Chapapate (Cuba). A kind of asphalt or bitumen. Also called Mexican asphalt. (Century)

Chapapote (Mex.). Mineral pitch; asphaltum. (Halse)

Chaparral (Sp.). A thicket of dwarf evergreen oaks; any dense impenetrable thicket composed of stiff, thorny shrubs, or dwarf trees. Characteristic of Mexico and Southwestern United States. (Webster)

Chapeau de fer. A French term for an oxidized iron outcrop; gossan or iron hat. (Weed)

Chapelet. 1. A machine for raising water, or for dredging, by buckets on an endless chain passing between two rotating sprocket wheels. 2. A chain pump having buttons or disks at intervals along its chain; paternoster pump. 3. A device for holding the end of heavy work, as a cannon, in a turning lathe. (Standard)

Chapeo (Port.). Gossan. *See also* Colorados. (Halse)

Chapman shield. A pair of vertical plates of sheet iron or steel arranged with a ladle between them, which can be moved longitudinally along the front of the furnace. Its main purpose is to protect the laborer from the furnace heat. (Ingalls, p. 494)

Chaqueta (Mex.). A furnace jacket. (Dwight)

Chaquires (Peru). Ore carriers in mines. (Dwight)

Char. 1. To reduce to charcoal or carbon by exposure to heat. (Webster)
2. (Corn.). To work by the day. (Crofutt). *See also* Chare.
3. (Scot.). Coke; more usually, calcined ironstone. (Barrowman)

Charbon roux (Fr.) Brown charcoal, produced by an incomplete carbonization of wood. (Raymond)

Charco (Mex.). A pool of water. (Dwight)

Charcoal. 1. Amorphous carbon prepared from vegetal or animal substances; coal made by charring wood in a kiln or retort from which air is excluded. 2. To asphyxiate with charcoal fumes. (Webster)

Charcoal furnace, or oven. A furnace in which charcoal is made by the dry distillation of wood or other substance. (Webster)

Charcoal iron. Iron made in a furnace in which charcoal is used as a fuel. (Webster)

Charcoal pit. A charcoal furnace in the form of a pit, usually conical in shape. It is made by piling up wood and covering it with earth and sod. (Century)

Charcoal plate. Charcoal iron coated with tin (Standard). The best grade of tin plate. *See also* Tin plate.

Charcón (Colom.). A large pond or tank of water. (Halse)

Chare; Char. To work by the day without being hired regularly; to do odd jobs or chores. (Webster)

Charge. 1. The explosive loaded into a bore hole for blasting; also any unit of an explosive, as a charge of nitroglycerin or a charge of detonating composition in the blasting cap. (Du Pont)
2. To put the explosive into the hole, to arrange the fuse, or squib, and to tamp it. (Steel)
3. The materials introduced at one time or one round into a furnace. (Raymond)

Chargeman (Mid.). A man specially appointed by the manager to fire shots and to look after the men who drill the holes. (Gresley.) A shotfirer.

Charger (Corn.). An augerlike implement for charging horizontal bore holes for blasting. (Raymond)

Chargeur (Belg.). A woman or girl who loads coal into cars in the mine. (Gresley)

Charging. 1. The loading of a bore hole with explosives. (Du Pont)
2. The feeding of a blast furnace.

Charging box. A box in which ore, scrap, pig-iron, fluxes, etc., are conveyed to the furnace by means of a charging machine. (Century)

Charging machine. A machine for delivering coal, ore, or metals to a furnace, gas retort, or coke oven. (Century)

Charging scale. A scale for weighing the various materials used in a blast furnace. (Century)

Chark. 1. To burn to charcoal; to char; to coke, as coal. 2. As a noun, charcoal, coke, cinder. (Webster)

Charnockite. A name given by T. H. Holland to an ancient series of hypersthenic gneisses in India and only intended for local use. (Kemp)

Char-oven. A furnace for charring turf. (Century)

Charque (Bol.). Native copper in large wavy plates. (Halse)

Charqueador (Mex.). 1. The striker in two-handed drilling. 2. The helper who, under the old system, sorted the material from ground worked down by the miner. *See also* Achicador. (Dwight)

Charquear (Mex.). To dip out water from pools within a mine, throwing it into gutters or pipes which will conduct it to the shaft. *See also* Achicar. (Dwight)

Charqueo (Sp.). Filling the baskets by hand. (Min. Jour.)

Charring. The expulsion by heat of the volatile constituents of wood, etc., leaving more or less pure vegetal carbon. (Raymond)

Charter (Mid.). The tonnage price paid to contract miners. (Gresley)

Charter master (Staff.). A contractor who engages to work a seam, or sometimes a small colliery, at a tonnage price for the owner, or owners, the charter master finding and paying the underground labor (Redmayne). *See also* Butty, 2.

Chase; Chess the ropes (Eng.). To run the cages up and down the shaft after the winding engine has been standing for some time, to see that all is right before men are allowed to get into the cage. (G. C. Greenwell)

Chaser. An edge wheel revolving in a trough to crush asbestos mineral without destroying the fiber (Webster). Also called Edge runner, and used in the pottery industry, and for fine crushing of ore.

Chasha (Russ.). A disintegrator for gold-bearing gravelly clays; similar to an arrastre except that it disintegrates instead of crushes.

Chasing. 1. Following a vein by its range or direction (Duryee).
2. Act or art of ornamenting metals by means of chasing tools. 3. The process of finishing up the surface of castings by polishing and removing small imperfections. (Webster)

Chasing the vein (Derb.). Following the vein along the surface by means of cast holes or prospect pits. (Hoosa)

Chasm. 1. A yawning hollow or rent, as in the earth's surface; any wide and deep gap; a cleft; fissure. (Standard)

Chatón (Sp.). A kind of coarse diamond. (Halse)

Chatoyant. Having a luster resembling the changing luster of the eye of the cat at night. (George). *See also* Cat's-eye.

Chat-roller. An ore-crushing machine, consisting of a pair of cast-iron rollers, for grinding roasted ore. (Century)

Chats. 1. (Northumb.) Small pieces of stone with ore (Raymond). (Eng.) A low grade of lead ore. Also middlings which are to be crushed and subjected to further treatment (Ure). The mineral and rocks mixed together which must be crushed and cleaned before sold as mineral. Chats are not the same as tailings, as the latter are not thrown aside to keep for future milling. (Cleveland & Aurora Mineral Land Co. *v.* Ross, 135 Missouri, p. 110)
2. Loosely used in Missouri for tailings or waste product from the concentration of lead and zinc ore.

Chatter mark. One of a series of short curved cracks on a glaciated rock surface. The individual cracks are transverse roughly to the striæ, but the course of a series of chatter marks is parallel to the striæ. (Webster)

Chaya (Chile). A wooden dish used in alluvial mining; a *batea*.-(Halse)

Check. 1. A piece of tin bearing a stamped number. This is placed upon the mine cars to indicate which miner loaded the car. (Steel)
2. A ticket by which a person or thing may be identified. 3. An imperceptible crack in steel caused by uneven quenching and cooling. (Webster)
4. (Eng.). A fault. (Gresley)
5. A wall. A variation of cheek.

Check battery. A battery to close the lower part of a chute acting as a check to the flow of coal, and as a stopping to keep the air in the breasts. (Chance)

Check brakes (Aust.). An arrangement for automatically checking the speed of skip running down an incline when unattached to a rope. (Power)

Check clack (Scot.). A fixed valve in a rising main other than a delivery valve. (Barrowman) *See also* Check valve.

Checker arches. Fire brick supports built of archbrick or keys to support the checker work on the second, third, or fourth pass of hot-blast stoves. (Willcox)

Checkerboard system. *See* Bord-and-pillar method.

Checker coal. Anthracite coal that occurs as rectangular grains. (C. and M. M. P.)

Checkerwork. In a regenerative furnace, a structure of firebrick so built up that the bricks alternate with open spaces, permitting the passage of heated gases. (Webster)

Check grieve (Scot.). A person who checks the weight of mineral on behalf of the landlord (Barrowman). *Compare* Check weigher.

Checking. Temporarily reducing the temperature or the volume of the air blast on a blast furnace. (Willcox)

Check number. A number assigned to each miner by which his coal is identified, and under which its weight is entered on the coal bulletin (Steel). *See also* Check, 1.

Check-off. A method of collecting union dues, fees, and fines by withholding them from the miner's wages. (Steel)

Check-out (Scot.). The meeting of the roof and floor, the coal seam being thereby cut off (Barrowman). To pinch out.

Check puller. A person who takes the miner's checks from the cars and calls the number on them to the weighman. (Steel)

Check valve. An automatic nonreturn valve; or a valve which permits a fluid to pass in one direction, but automatically closes when the fluid attempts to pass in the opposite direction. (Nat. Tube Co.)

Check viewer (Eng.). A man employed by the lessor to see that the provisions of the lease are duly observed. (G. C. Greenwell)

Checkweigher (Scot.). One who takes account of mineral raised on behalf of the miners; a justiceman (Barrowman). A checkweighman. *Compare* Check grieve.

Checkweighman (Aust.). *See* Checkweigher.

Cheeks. 1. The sides or walls of a vein. 2. Extensions of the sides of the eye of a hammer or pick. (Raymond)
3. (Eng.). Projecting masses of coal. (Gresley)

Cheese box. A name given to a cylindrical still, used in the distillation of kerosene in the United States. (Mitzakis)

Cheese clack (Scot.). A temporary clack (valve) inserted between two pipes. (Barrowman)

Cheeses (Derb.). Clay ironstone in cheese-shaped nodules. (Gresley)

Cheese weights (Aust.). The circular cheese-shaped weights used to keep guide ropes taut. (Power)

Cheestone (Derb.). A stone that by reason of a joint breaks further into the wall than usual. (Hooson)

Chemawinite. A resin related to succinite, occurring on a beach on Cedar Lake, near the mouth of the North Saskatchewan; it has a specific gravity of 1.055, its color varies from pale yellow to dark brown, and it is soluble to the extent of 21 per cent in absolute alcohol. (Bacon)

Chemical mineralogy. The investigation of the chemical composition of minerals, their method of formation, and the changes they undergo when acted upon chemically. (Century)

Chemical regeneration. A system of regenerative gas firing invented by Friedrich Siemens. (Ingalls, p. 364)

Chemist. A person versed in chemistry; one whose business is to make chemical examinations or investigations, or who is engaged in the operations of applied chemistry. (Century)

Chemistry. The science that treats of the composition of substances and of the transformations which they undergo. There are two main groups. (a) Organic chemistry, which treats of the hydrocarbons and their derivatives, and (b) inorganic chemistry treats of all other compounds, and of the elements. (Webster). *See* numerous textbooks and dictionaries which have been published on this subject for details and definitions of chemical terms.

Chemist's coal (Scot.). An ancient term given to a particular kind of hard splint coal. (Gresley)

Chemites. A word employed by M. E. Wadsworth to embrace all mineral chemical materials. (Power)

Chenevixite. A massive to compact dark-green to greenish-yellow hydrous arsenate, perhaps $Cu_2(FeO)_2As_2O_8+8H_2O$. (Dana)

Chenhall furnace. A gas-fired furnace for the distillation of zinc from zinc-lead ores. (Ingalls, p. 395)

Chenot process. The process of making iron sponge from ore mixed with coal dust and heated in vertical cylindrical retorts. (Raymond)

Cherkers (Forest of Dean). *See* Cathead, 3.

Cherry coal. A soft noncaking coal which burns readily. (Webster). A deep black, dull, or lustrous bituminous coal, with a somewhat conchoidal fracture, readily breaking up into cuboidal fragments. It ignites easily with a yellowish flame, making a hot, quick fire, and retains its shape until thoroughly consumed. Its specific gravity is much less than anthracite, about 1.30. (Chance)

Chert. A compact, siliceous rock formed of chalcedonic or opaline silica, one or both, and of organic or precipitated origin. Chert occurs distributed through limestone, affording cherty limestones. Flint is

a variety of chert. Chert is especially common in the Carboniferous rocks of southwest Missouri (Kemp). *See also* Hornstone.

Chessy copper. Same as Chessylite; azurite. (Century)

Chessylite. A synonym for Azurite. (A. F. Rogers)

Chest. 1. A tight receptacle or box for holding gas, liquids, steam, as steam chest of an engine. (Webster) 2. (Scot.). A tank or barrel in which water is drawn from the sump. (Gresley)

Chesting (Scot.). Drawing water by means of a chest (Barrowman). *See also* Chest, 2.

Chestnut coal. 1. In anthracite only—Coal small enough to pass through a square mesh of one inch to one and one-eighth inch, but too large to pass through a mesh of five-eighths or one-half an inch. Known as No. 5 coal. (Chance)
2. (Ark.). Coal that passes through a 2-in. round hole and over a 1-in. round hole. (Steel)

Chews; Chows (Scot.). Coal loaded with a screening shovel; middling-sized pieces of coal. (Barrowman)

Chiastolite; Maele. A variety of andalusite, aluminum silicate, $Al_2O_3.SiO_2$, in which carbonaceous impurities are arranged in a regular manner along the longer axis of the crystal, in some varieties like the *X* (Greek "chi"), whence the name (U. S. Geol. Surv.)

Chicadero (Sp. Am.). A dyke, a dam (Lucas). *See also* Chamburgo.

Chicar (Colom.). To bale water out of mines (Halse). A synonym for Achicar.

Chicken ladder. *See* Muesca.

Chicuite (Sp.). *See* Chiquichuite.

Chidder. (Aust.). Slate and pyrite mixed. (Power)

Chifadero (Mex.). An ore hopper.

Chifarse (Mex.). To waste itself (as the force of an explosion, through a fissure in the rock). (Dwight)

Chifón (Mex.). 1. A narrow drift directed obliquely downward. 2. Any pipe from which issues water or air under pressure, or at high velocity. 3. A strong draft of air. (Dwight)

Chile. 1. (Peru) The greatest depth of a mine. (Dwight)
2. A descending gallery following the dip of a vein. 3. (Mex.) A refractory clay. (Halse)

Chilean mill; Edge runner. A mill having vertical rollers running in a circular enclosure with a stone or iron base or die. There are two classes: (a) those in which the rollers gyrate around a central axis, rolling upon the die as they go (the true Chilian mill); (b) those in which the enclosure or pan revolves, and the rollers, placed on a fixed axis, are in turn revolved by the pan. It was formerly used as a coarse grinder, but is now used for fine grinding. (Liddell)

Chile bars. Bars of impure copper, weighing about 200 lbs., imported from Chile, corresponding to the Welsh blister copper, containing 98 per cent copper. (C. and M. M. P.)

Chilenite. A soft silver-white amorphous silver bismuth, Ag_6Bi (Standard). Bismuth silver.

Chileno (Mex.). A Chilian mill. (Dwight)

Chile saltpeter. Sodium nitrate.

Chill. 1. An iron mold or portion of a mold, serving to cool rapidly, and so to harden, the surface of molten iron which comes in contact with it. Iron which can be thus hardened to a considerable depth is chilling iron, and is specially used for cast-iron railway car wheels requiring hardness at the rim without loss of strength in the wheel. (Raymond)
2. The hardened part of a casting, as the tread of a car wheel. (Webster)
3. (Derb.) To test the roof with a tool or bar to determine its safety. (Hooson)

Chilled casting. A casting which has been chilled, either by casting in contact with something which will rapidly conduct the heat from it, as a cool iron mold, or by sudden cooling by exposure to air or water. (Century)

Chilled dynamite. The condition of the dynamite when subjected to a low temperature not sufficient to congeal it, but which seriously affects the strength of the dynamite. (Du Pont)

Chill hardening. *See* Chill.

Chiluca (Mex.). A variety of porphyry. (Dwight)

Chimenea (Sp.). 1. A chimney; smokestack. 2. A hearth; a fireplace. 3. A vertical shaft; a winze. 4. (Peru). An ascending gallery following the inclination of the vein. (Halse)

Chimming (Corn.). *See* Tossing.

Chimney. 1. An ore shoot. *Compare* Chute, 2 (Raymond). 2. A steep and very narrow cleft or gully in the face of a cliff or mountain. 3. A smokestack. 4. A natural vent or opening in the earth as a volcano. (Webster)
5. (Eng.). A spout or pit in the goaf of vertical coal seams. (Gresley)
6. A term used in Virginia for limestone pinnacles bounding zinc ore deposits.

Chimney rock. A chimney-shaped body of rock rising above its surroundings, or partly isolated on the face of a steep slope. (Webster). *See also* Chimney, 6.

Chimney shot (N. Y.). A local term applied to the effect of an overcharge of explosive in a line of drill holes, the effect being to throw the rock to some distance, forming a deep trench. (Bowles)

Chimney work (Mid.). A system of working beds of clay ironstone, in patches 10 to 80 yards square, and 18 or 20 feet in thickness. The bottom beds are first worked out, and then the higher ones, by the miners standing upon the fallen débris; and so on upward in lifts. *See also* Rake (Gresley). *Compare* Overhand stoping.

China clay. Clay derived from decomposition of feldspar and suitable for the manufacture of china ware or porcelain. *See* Kaolin.

China metal. Porcelain. (Webster)

China stone. A semi-decomposed granite, which has nearly the same composition as china clay. (Ure)

Chinese pump. Like a California pump, but made entirely of wood. (C. and M. M. P.)

Chingle. 1. (Scot.). A gravel free from dirt. *See also* Shingle. 2. That portion of the coal seam stowed away in the goaves to help support the mine roof. (Century)

Chink. 1. A small rent, cleft or fissure of greater length than breadth. (Webster)
2. (Scot.). A sharp, clear, metallic sound. (Century)

Chinley coal (Eng.). Lump coal which passes over a screen; usually the best coal. (G. C. Greenwell)

Chino (Sp.). Iron or copper pyrite (Min. Jour.)

Chiolite. A snow-white fluoride of s dium and aluminum, 5NaF.3Al F crystallizing in the tetragonal sy tem and also occurring in massi granular form. (Dana)

Chipper (Derb.). One who chips th gangue from the ore. An or dresser. (Hooson)

Chippy. *See* Rock drill.

Chiquichuite (Sp.). A willow baske without a handle, used for carryin ore, etc., out of mines. Sometime spelled Chicuite.

Chiquero (Sp.). Cribbing or chock used in timbering wide seams o lodes. (Halse)

Chirls; Churrels (Scot.). Coal whic passes through a screening shovel small coal free from dross or dirt (Barrowman)

Chirt; Chirtt (Derb.). *See* Chert.

Chisel. *See* Bit.

Chisel draft. The dressed edge of a stone, which serves as a guide in cutting the rest. (Century)

Chispa (Mex.). 1. A spark. 2. Ore containing visible gold. A nugget. 3. Native silver in thin leaves. (Halse)

Chispeada (Batopilas, Mex.). Ore containing about 33 per cent native silver. (Dwight)

Chispiador (Peru). A gold washer in river placers. (Dwight)

Chitter. 1. (Lanc.) A seam of coal overlying another one at a short distance. 2. (Derb.). A thin band of clay ironstone. (Gresley)

Chiva (Mex.). A bar with a claw for drawing spikes (Dwight)

Chiviar (Mex.). To hunt for broken ore in waste. (Dwight)

Chiviatite. A foliated. massive, metallic, lead-gray sulphide of lead and bismuth, $2PbS.3Bi_2S_3$. (Dana)

Chloanthite. A nickel diarsenide, $NiAs_2$. (Dana)

Chloralluminite. A hydrous aluminum chloride, $AlCl_3+H_2O$, that occurs as a volcanic product. (Standard)

Chloralum. An impure aqueous solution of aluminum chloride used as an antiseptic. (Webster)

Chlorapatite. *See* Apatite.

Chlorastrolite. Not a definite mineral but probably a mixture of zeolites. Found as small, light bluish-green pebbles, with finely radiated structure, on Isle Royale, Lake Superior. Used as a gem. (U. S. Geol. Surv.)

Chlorate powder. A substitute for black powder in which potassium chlorate is used in place of potassium nitrate. This class of explosive has received little attention on account of greater sensitiveness to shock and friction. (Brunswig, p. 302)

Chloride. 1. A compound of chlorine with another element or radical. A salt of hydrochloric acid. (Webster)
2. To follow a thin vein or discontinuous ore deposit by irregular workings, intent only on extracting the profitable parts and with no regard for development; usually said of a lessee, sometimes of one who works another's mine without permission. The term is said to have originated at Silver Reef in southwestern Utah when the rich silver-chloride ores were being worked. The thin seams were followed by lessees with the least possible handling of barren rock, hence the miner became a chlorider, and his operations chloriding. The words were later extended to similar workers and their operations in other fields. (F. L. Hess)

Chlorider. *See* Chloride, 2.

Chlorides (Pac.). A common term for ores containing chloride of silver. (Raymond)

Chloridize. To convert into chloride. Applied to the roasting of silver ores with salt, preparatory to amalgamation. (Raymond)

Chlorination process. The process first introduced by Plattner, in which auriferous ores are first roasted to oxidize the base metals, then saturated with chlorine gas, and finally treated with water, which removes the soluble chloride of gold, to be subsequently precipitated and melted into bars. (Raymond)

Chlorine. An element, commonly isolated as a greenish-yellow gas, of an intensely disagreeable suffocating odor and exceedingly poisonous. Symbol, Cl; atomic weight, 35.46. Specific gravity, 2.5. (Webster)

Chlorine minerals. Minerals containing chlorine, such as atacamite, boracite, apatite, carnallite, cerargyrite, halite, mimetite, pyromorphite, salammoniac, sylvite, sodalite, vanadinite, wernerite, etc. (A. F. Rogers)

Chlorite. 1. A silicate of aluminum with ferrous iron and magnesium and chemically combined water, characterized by the green color common with silicates in which ferrous iron is prominent. (Dana)
2. A general name for the green, secondary, hydrated silicates, which contain aluminum and iron, and which are especially derived from augite, hornblende, and biotite. Chlorite is used as a prefix for various names of rocks that contain the mineral, such as chlorite schist. The name is coined from the Greek word for green. (Kemp)
3. In chemistry, a salt of chlorous acid. (Webster)

Chlorite slate. A schistose or slaty rock consisting largely of chlorite. (Webster)

Chloritic sand. Sand colored green by chlorite as a constituent. (Comstock)

Chloritic schist. Schist containing chlorite. (Hitchcock)

Chloritization. Metamorphic alteration of other material into chlorite. (Standard)

Chlorocyanic. Consisting of chlorine and cyanogen combined. (Century)

Chloromelanite. A dark green, nearly black variety of jadeite. (Century)

Chloropal. A green, opal-like hydrous silicate of iron, $Fe_2O_3.3SiO_2.5H_2O$. (Dana)

Chlorophane. A variety of fluorspar which exhibits a bright green phosphorescent light when heated. (Century)

Chlorophyr. A name given by A. Dumont to certain porphyritic quartz diorites near Quenast, Belgium.

Chlorospinel. A variety of spinel, grass-green in color, due to the presence of copper. Contains iron replacing the aluminum; $MgO(Al,Fe)_2O_3$. Also called Magnesium - iron spinel. (Dana)

Chlorotile. A green, hydrated copper arsenate, $Cu_3(AsO_4)_2.6H_2O$, that crystallizes in the orthorhombic system. (Standard)

Chocar (Colom.). To break up the auriferous gravels, cement rock, etc., with water, using bars and other tools, in order that the loosened material may be conducted to the ground sluice. (Halse)

Chock. 1. A square pillar for supporting the roof, constructed of prop timber laid up in alternate cross-layers, in log-cabin style, the center being filled with waste. Commonly called Crib in Arkansas (Steel). *See* Cogs, *also* Nog.
2. A square pillar constructed of short rectangular blocks of hardwood, for supporting the roof. (Gresley)
3. Two blocks of hardwood placed across the rail or between rails to prevent tubs, cars, or wagons from running down incline. (Greenwell)

Chock and block (Newc.). Tightly filled up. (Min. Jour.)

Choclo de oro (Peru). A mass of native gold (say 1 oz. or more) in its matrix. (Dwight)

Chocolate. A very fine-grained mica schist found in New Hampshire and used extensively in the manufacture of scythe stones, axe stones and knife stones. (Pike)

Chocolón (Mex.). 1. The part of the hole remaining in the rock after a blast. 2. A hitch cut in the rock. (Dwight)

Chocú (Peru). A disease caused by inhaling fine mineral dust, as in a stamp mill. (Dwight)

Chogs (York.). Blocks of wood for keeping pump-trees or other vertical pipes plumb (Gresley). *See* Collar, 6, and Collaring, 1.

Choke crushing. A recrushing of fine ore due to the fact that the broken material cannot find its way from the machine before it is again crushed. *See also* Free crushing. (Richards, p. 98)

Choke damp. 1. A mine atmosphere that causes choking, or suffocation, due to insufficient oxygen. As applied to "air" that causes choking, does not mean any single gas or combination of gases. 2. A name sometimes given in England to carbon dioxide.

Cholla (Mex.). An opening or hollow space; a small space filled with soft ore. (Dwight)

Chondrite. A meteoric stone characterized by the presence of chondrules. (Webster)

Chondrodite. One of the humite group. A basic fluosilicate of magnesium. (Dana)

Chondrule. A peculiar rounded granule of cosmic origin, usually consisting of enstatite or chrysotile. Occurs in meteorites. (Webster)

Chonkole. A Malayan spade. (Lock)

Chonolith. An injected igneous mass, so irregular in form and obscure as to relation to the invaded formations, that it can not be properly designated as a dike, sill, or laccolithic form. (Daly, p. 84)

Chop (Som.). A local term for fault. (Gresley)

Chorlo (Mex.). Tourmaline crystals. (Lucas)

Chorometry. Land surveying. (Standard)

Chorrera (Mex.). An ore shoot; a run of loose rock. (Dwight)

Chorro (Mex.). A spring of water found in mines. Jet or spout of liquid. (Dwight)

Chorroeadero (Mex.). 1. A chute for ore. 2. Loose or running ground. (Dwight)

Christmatite. A butyraceous, greenish-yellow to wax-yellow hydrocarbon from Wettin, Saxony; it has a specific gravity of less than 1 and is soft at 55° to 60° C. (Bacon)

Christobalite. A dull white silicon dioxide (SiO_2), that crystallizes in the orthorhombic system, and is closely related to tridymite. (Standard)

Chromatites. A term used by M. E. Wadsworth to include mineral coloring matter, paints, pigments, etc. (Power)

Chrome. Chromium; also, in dyeing, potassium dichromate.

Chrome steel. *See* Chromium steel.

Chrome garnet. A synonym for Uvarovite. (A. F. Rogers)

Chrome iron ore. A synonym for Chromite. (A. F. Rogers)

Chrome ocher. A clayey ocher colored green with chromium oxide. (Standard)

Chromite. A chromate of iron, $FeO.Cr_2O_3$. Contains 68 per cent chromic oxide. (U. S. Geol. Surv.)

Chromium. A brilliant tin-white, comparatively rare metal, hard, brittle, and refractory. Symbol, Cr; atomic weight, 52.0. Specific gravity, 6.8.

Chromium steel. An iron-chromium alloy that hardens intensely on sudden cooling, and is used for the manufacture of armor-piercing projectiles, safe-plates, and crushing machinery. It contains about 16 per cent chromium; does not rust under ordinary conditions and is also called Stainless steel.

Chromometer. An instrument for determining the color of petroleum and other oils. (Standard)

Chromowulfenite. A red variety of wulfenite, containing some chromium. (Chester)

Chrysoberyl. A glucinum-aluminum oxide, $GlO.Al_2O_3$, known as cat's-eye when it has a chatoyant luster. (U. S. Geol. Surv.)

Chrysocolla. A hydrous copper silicate. Contains theoretically about 36 per cent of copper. (U. S. Geol. Surv.) Generally green or blue-green.

Chrysolite. An iron-magnesium silicate of a yellowish-green, sometimes brownish or reddish. A common mineral in basalt and diorite. Commonly called Olivine. When used as a gem it is called Peridot.

Chrysoprase. An apple-green chalcedony, the color of which is due to nickel. (U. S. Geol. Surv.)

Chrysotile. Fibrous serpentine. *See also* Asbestos. (U. S. Geol. Surv.)

Chúa (Bol. and Chile) A testing saucer. (Lucas)

Chuck. 1. That part of a machine drill which grips or holds the drill. (Gillete, p. 99)
2. A device for holding an object so that it can be rotated, as upon the mandrel of a lathe or for fixing it in a drill-press, planer, etc. (Standard)

Chuck block; Chock block. The wooden block or board which is attached to the bottom of the screen so as to raise the depth of the issue and act as a false lip to the mortar, in stamp milling. (Rickard)

Chuga (Mex.). *See* Peruña.

Chulano (Mex.). An upper drill hole. (Dwight)

Chulanista (Braz.). One who drills uppers. (Bensusan)

Chumacera (Mex.). A bearing for the shaft of a machine. (Dwight)

Chumbe. 1. (Mex. and Bol.) Zinc-blende. 2. (Colom.) A strap of colored wool for carrying a sachel or purse. (Halse)

Chumbo. 1. (Port.) Lead. 2. (Braz.) Pyrite. (Halse)

Chump (Eng.). To drill a shot hole by hand. (Gresley)

Chumpe (Peru). *See* Chumbe.

Chun (Derb.). A clay or soft gouge between two hard walls. (Hooson)

Chunked-up. Built up with large lumps of coal to increase the capacity of a car. Also called Built-up. (Steel)

Chunk mineral. In Wisconsin, applied to masses of galena as broken out of the mine. (Power)

Churchite. A hydrous phosphate of cerium. (Chester)

Churn drill. 1. Also called Cable drill or Well drill. A portable drilling equipment usually mounted on four wheels and driven by gasoline, electricity, or steam. Also applied to a stationary drill operated from a derrick as in oil-well drilling. The drill head is raised by means of a rope or cable and allowed to drop, thus striking successive blows by means of which the rock is pulverized and the hole deepened. (Bowles)
2. A long iron bar with a cutting end of steel, used in quarrying, and worked by raising and letting it fall. When worked by blows of a hammer or sledge, it is called a "jumper." (Steel)

Churns (Forest of Dean). Ironstone workings in cavern-shaped excavations. A rough chamber-and-pillar system of working. (Gresley)

Churumbela (Colom.). A micaceous and talcose schist. (Halse)

Churusca (Bol.). Copper pyrites. (Halse)

Chute. (Sometimes written shoot) 1. A channel or shaft underground, or an inclined trough above ground, through which ore falls or is "shot" by gravity from a higher to a lower level. (Raymond.) 2. (Penn.) A crosscut connecting a gangway with a heading. (Gresley.) 3. An inclined water course, natural or artificial, especially one through which boats or timber are carried, as in a dam. 4. A narrow channel with a

free current, especially on the lower Mississippi River. (Standard) 5. A body of ore, usually of elongated form, extending downward within a vein (ore shoot). The two forms of orthography of this word are of French and English origin respectively. Under chute, the original idea is that of falling; under shoot, that of shooting or branching. Both are appropriate to the technical significations of the word. An ore shoot, for instance, may be considered as a branch of the general mass of the ore in a deposit, or as a pitch or fall of ore (German, Erzfall). In England the orthography "shoot" is, I believe, exclusively employed, and this is perhaps the best as applied to ore deposits, the other being unnecessarily foreign. (Raymond)

Chute caving. The method involves both overhand stoping and ore caving. The chamber is started as an overhand stope from the head of a chute and is extended up until the back weakens sufficiently to cave. The orebody is worked from the top down in thick slices, each slice being, however, attacked from the bottom and the working extending from the floor of the slice up to an intermediate point. The cover follows down upon the caved ore (Young). Also called "Caving by raising" and "Block caving into chutes."

Chute system. *See* Glory hole system. (Young)

Chuza (Mex.). A catch basin for mercury. (Dwight)

Chuzo (Chile). A pointed tool used in washing gold in sluices, in extracting borax in large pieces, etc. (Halse)

Cianógeno (Mex.). Cyanogen. (Dwight)

Cianuro (Mex.). Cyanide. (Dwight)

Cielo (Mex.). 1. Roof; ceiling. 2. *Trabajar de cielo*, overhand stoping. (Dwight)

C. I. F. A commercial transportation term meaning "Cost, Insurance, and Freight." It is intended to cover the cost of certain goods at point of destination. (Nat. Tube Co.) Usually applied only to maritime freight.

Cigualro; Civairo (Peru). Peacock colored. (Dwight)

Cigüeña (Mex.). A windlass; a crank. (Dwight)

Cilindros (Mex.). Rolls. (Dwight)

Cima (Mex.). Summit. (Dwight)

Cimbra. 1. (Mex.). A center for an arch. (Dwight)
2. (Colom.). Primitive stamps worked by manual labor. (Halse)

Ciminite. A name derived from the Monti Cimini in Italy, and given by H. S. Washington to a group of lavas, intermediate between trachytes and basalts. They are porpyritic in texture and are characterized by the presence of alkali feldspar and basic plagioclase, augite and olivine, with accessory magnetite and apatite. Biotite and hornblende are either absent or are insignificant. They range from 54 to 57 SiO_2, 5–9 CaO, and 3–6 MgO. *Compare* Latite. (Kemp)

Cimolite. A white, grayish or reddish hydrosilicate of aluminum, soft and claylike or chalklike in appearance. (Dana)

Cinabrio (Mex.). Cinnabar. (Dwight)

Cincel. 1. (Peru) Native silver in large masses. (Dwight)
2. (Colum.) A stone chisel used by the Indians. (Halse)

Cincho (Mex.). 1. A belt or girdle. 2. A horizontal timber used for wedging a stemple against a plank on the hanging wall. (Halse)

Cincinnatian. In the usage of the U. S. Geological Survey, the third and youngest of the series of strata comprised in the Ordovician system. Also the corresponding epoch. (La Forge)

Cinder. 1. Slag, particularly from iron blast furnaces. (Raymond)
2. A scale thrown off in forging metal. 3. Scoriaceous lava from a volcano; volcanic scoria. (Webster)

Cinder bank. Same as cinder dump. Also indicates an old dump as distiguished from one in use. (Willcox)

Cinder bed (Eng.) A stratum of the Upper Purbeck series, almost wholly composed of oyster-shells; and so named by the quarrymen from its loose incoherent composition. (Page)

Cinder block. A block closing the front of a blast furnace and containing the cinder notch. (Webster)

Cinder breakout. The slag within the furnace escaping through the brickwork. Caused by erosion, corrosion, or softening of brick by heat. (Willcox)

Cinder coal. 1. (Eng.) Coal altered by heat from an intrusion of lava. (Gresley)
2. (Aust.) A very inferior natural coke, little better than ash. (Power)

Cinder cone. A volcanic cone composed of scoria.

Cinder dock. A bed containing molds into which, in former practice, cinder was run, chilled, and then thrown into cars with forks. (Willcox)

Cinder dump. A place where cinder ladles are emptied. (Willcox)

Cinder fall. The dam over which the slag from the cinder notch of a furnace flows. (Century)

Cinder notch. The hole, about 5 or 6 feet above the iron notch, and 8 feet below the tuyères, through which slag is flushed two to three times between casts (Willcox). *See also* Cinder tap.

Cinder pig. Iron made from ores with admixture of some forge or mill-cinder (Raymond). *See also* Pig iron.

Cinder pit. Large pit filled with water into which molten cinder is run and granulated at cast or flush. (Willcox)

Cinder plate. *See* Bloomery.

Cinder runner. A trough carrying slag from skimmer, or cinder notch, to pit or ladle. *See also* Cinder notch. (Willcox)

Cinder snapper. A man who removes cinder skulls from cinder runners. (Willcox)

Cinder tap; Cinder notch. The hole through which cinder is tapped from a furnace. Also called Lurmann front. (Raymond)

Cinder tub. A shallow iron truck with movable sides into which the slag of a furnace flows from the cinder runner. (Century)

Cinder wool. A fibrous glass obtained by the action of a jet of air or steam upon molten slag as it flows from a blast furnace. Commonly called Mineral wool. (Century)

Cinnabar. A vermilion-colored mercury sulphide, HgS, 86 per cent mercury. It is the common ore of mercury and occurs as hexagonal crystals. *See also* Metacinnabarite. (U. S. Geol. Surv.)

Cinnamite. Same as Cinnamon stone. (Century)

Cinnamon stone. Essonite; a variety of garnet. (Power)

Cinta. 1. (Sp.). A surveyor's tape. 2. (Mex.). A layer or band of mineral in a vein. 3. (Colom.). Pay dirt in placers. (Halse)

Cintarrón (Sp. Am.). A bed of auriferous gravel of unusual thickness. (Lucas)

Cinteada (Mex.). A banded or ribboned structure of veins. (Halse)

Cipolino marble. A white crystalline limestone traversed by veins of greenish mica; a favorite Italian marble. (Merrill)

Circa (Latin). About; around; often used in English with numerals to denote approximate accuracy. (Webster)

Circle cutting drill. Same as Ditcher. (Bowles)

Circles (Ches.). Wavy, undulating streaks of various colors frequently seen in the sides of shafts, on the pillars, faces, and roof of rock-salt mines. (Gresley)

Circle spouts (Eng.). *See* Garland, 1.

Circuit breaker. An automatic device for breaking an electric circuit at the highest current which it may be called upon to carry (Webster). *See also* Cut-out, 3.

Circular cutting drill. *See* Ditcher.

Circular mil. A unit of area used in measuring cross-sections of wires; 0.7854 square mil (Standard). *See also* Mil.

Circular polarization. A phenomena observed in a polariscope when two plane polarized rays, propogated in the same direction, have their vibration directions at right angles to each other and differ by one-quarter of a wave-length in phase. (Dana)

Circulation. 1. The movement of the air currents of a mine. (Roy)
2. The act of moving in any course which brings the moving body to the place where its motion began. (Webster)

Cire-Perdue process. A process used in bronze casting; the lost-wax process. (Standard)

Cirque. A steep-walled, amphitheatral recess in a mountain side, generally ascribed to glacial erosion. (Webster)

Cisco (Sp.). 1. Coal broken into small bits. 2. Coal dust. (Halse)

Cispeado (Mex.). Ore of one-third silver and two-thirds calc spar. (Lucas)

Cistern. 1. An artificial reservoir or tank for holding or storing water or other liquids. (Webster)
2. The receptacle into which glass is ladled from the pots to be poured over the table in making plate glass or in casting glass; a cuvette. (Century)
3. In metallurgy, a settling tank for liquid slag, pulp, etc.

Citrate. A salt or ester of citric acid. (Webster)

Citrine; Citrine quartz. A yellow pellucid variety of quartz; false topaz. (Dana)

Civa (Mex.). A stump of a candle. (Dwight)

Civairo (Peru). A peacock color. *See also* Ciguario. (Dwight)

Clack (Corn.). A pump valve. (Raymond)

Clack door (Eng.). The opening into the valve chamber to facilitate repairs and renewals without unseating the pump or breaking the connections. (Chance). Also, an iron plate bolted to the pipe to close the opening. (Gresley)

Clack-door piece (Eng.). A cast-iron pipe having an opening in the side for access to the clack or valve.

Clack guard (Scot.). A ring to prevent undue opening of the clack. (Barrowman)

Clack lid (Scot.). The flap of a clack or stationary valve. (Barrowman)

Clack piece. The casting forming the valve chamber. (Chance)

Clack seat. The receptacle for a valve to rest on. (C. and M. M. P.)

Claco (Mex.). An old coin equal to ⅛ of a Mexican *real*. *See also* Tlaco. (Dwight)

Cladgy. A variation of **claggy.**

Claggy (Newc.). Adhesive. When the coal is tightly joined to the roof, the mine is said to have a claggy top (Raymond). Also spelled Cladgy.

Claggy top (Newc.). A mine roof to which coal adheres. (Min. Jour.)

Claim. 1. The portion of mining ground held under the Federal and local laws by one claimant or association, by virtue of one location and record (Raymond). Lode claims, maximum size 600 by 1,500 feet. Placer claims 660 by 1,320 feet. A claim is sometimes called a "location." *See* Mining claims. 2. (So. Afr.) The portion of land upon a goldfield to which a miner is legally entitled. A Transvaal claim has an area equal to 64,025 English square feet, and is about 155 feet along the strike of the reef, and 413 feet across the line of reef. (Skinner)

Clam (Eng.). A bracket or support for a pump (Bainbridge). A clamp.

Clamp. 1. A device for compressing and holding in position a piece or part, or holding or binding together two or more parts; usually with jaws or cheeks, at least one of them movable, that may be set together or closed by some device for obtaining leverage. 2. (Eng.) A pile of cut and dried peat. (Standard)
3. A number of bricks piled up in a particular form for burning. (Webster)
4. A pile of ore for roasting, or of coal for coking. (Century)

Clamping. The process of burning bricks in clamp. *See also* Clamp, 3. (Century)

Clamp kiln. A kiln built of sods for burning lime. (Century)

Clamshell. A hinged, two leaved self-loading scoop used in dredges, coal-ore-, and ash-loaders, and hoisting machinery. (Century)

Clanger (Eng.). *See* Clauncher, 1.

Clanny (Eng.). A safety lamp invented by Dr. W. R. Clanny in 1813. (Gresley)

Clapete. (Mex.). A clack valve. (Dwight)

Clap sill. In hydraulic engineering, a miter sill; the bottom part of the frame on which lock gates shut; a lock sill. (Century)

Clarifying tank. A tank for clarifying cyanide or other solutions and frequently provided with a filtering layer of sand, cotton waste, matting, etc. (Clennell, p. 280)

Clark process. A process for softening water by the addition of slaked lime, which precipitates calcium bicarbonate by forming with it the insoluble normal carbonate. (Webster)

Clare (Sp.). An open space on the lode, from which ore has been taken. (Crofutt)

Claroline. A mineral oil used as a solvent for natural gases. (Bacon)

Clastolite. A rock composed of other rock fragments. *See* Clastic.

Clasp. 1. A snugly fitting ferrule for connecting pump rods. (Gresley)
2. Any of the various forms of catch, for holding together two objects or parts of anything. (Webster)

Classifier. 1. A machine for separating ore from gangue or for cleaning coal from slack. (Webster)
2. A machine for grading the feed to concentrators so that each individual concentrator will receive its proper feed. Classifiers may be hydraulic (Richards) or surface-current box classifiers (spitzkasten). Classifiers are also used to separate sand from slime, water from sand, and water from slime. (Richards)

Clastic. A descriptive term applied to rock formed from the fragments of other rocks; fragmental. (Kemp)

Clat. *See* Claut, 1.

Clauncher. 1. (Eng.). A tool for cleaning blast holes (Bainbridge). Also called Clanger.
2. (Derb.). A piece of stone, that has a joint back of it, which becomes loose and falls when the heading has been driven past it. (Hooson)

Clausthalite. Lead selenide, PbSe. (Dana)

Claut. 1. (Scot.). A scraper with a long handle. (Barrowman)
2. Mud or rubbish heaped together. (Standard)

Clavar (Mex.). To nail; to drive a stake. (Dwight)

Clavo (Mex.). 1. Nail. 2. *C. bueno*, or *rico*, a rich pocket of ore. 3. *C. de metal*, an ore-shoot; pay-streak. (Dwight)

Clavos. 1. (Sp.) Masses of ore, and of native metals. (Davies)
2. Iron ore; in Mexican mines, a mass of rich ore. (Standard)
3. (Sp.) Inclusions of igneous rock in a sedimentary deposit. (Halse)

Clay. A natural substance or soft rock which, when finely ground and mixed with water, forms a pasty, moldable mass that preserves its shape when air dried; the particles soften and coalesce upon being highly heated and form a stony mass upon cooling. Clays differ greatly mineralogically and chemically and consequently in their physical properties. Most of them contain many impurities, but ordinarily their base is hydrous aluminum silicate. (U. S. Geol. Surv.)

Clayband (Wales). Argillaceous ironstone in thin beds. (Gresley)

Clay bank. 1. A bank of clay. 2. A dun yellowish color. (Webster)

Clay course. A clay seam or gouge found at the sides of some veins. (C. and M. M. P.)

Clay dam. 1. (Mid.) A stopping made of puddled and well-beaten clay, from 12 in. to 36 in. thick, and rammed into the roof, floor, and sides of the excavation made to receive it. 2. A stopping consisting of two walls of stout planks placed 18 to 24 inches apart, and supported on the outside by upright props, the intervening space being filled with clay. (Gresley)

Clayer (Scot.). A rod for forcing clay into joints of strata in wet shot holes (Barrowman). *See also* Clay iron.

Clay gall. A dry, curled "clay-shaving" resulting from the drying and cracking of mud which is later embedded and flattened in a sand stratum. (Lahee, p. 86)

Clay gouge. A thin seam of clay separating ore, or ore and rock. (Weed)

Clay gun. *See* Mud gun.

Clay hog (Mid.). *See* Wash fault.

Clay hole. A cavity, in a stone, filled with clayey or sandy material. (Gillette, p. 6)

Claying. Lining a bore hole with clay, to keep the powder dry. (Gresley)

Claying bar. A rod used for making a blast hole water-tight by driving clay into its crevices, in order to protect the charge. (Century)

Clay iron. An iron rod used for ramming clay into wet drill holes (Webster). *See* Bull, 1; *also* Claying bar.

Clay-ironstone. Clayey carbonate of iron. A heavy compact or fine grained clayey looking stone, occurring in nodules and uneven beds among carboniferous and other rocks. It contains only 20 to 30 per cent of iron, and yet much of the iron produced by Great Britain is made from it. (Roy. Com.)

Clay kiln. A kiln or stove for burning clay. (Century)

Clay marl. A whitish, smooth, chalky clay; a marl in which clay predominates. (Webster)

Clay mill. A mill for mixing and tempering clay; a pug mill. (Century)

Clay pan (Aust.). A shallow depression covered with a clayey deposit which prevents the water from sinking quickly into the ground. (Webster)

Clay parting. Clayey material bound between a vein and its wall. Also called Casing and Parting. (Duryee)

Clay pit. A pit where clay is dug. (Century)

Clay pocket. A clay-filled erosion cavity in a rock ledge. (Bowles)

Clay rock. A rock made up of fine argillaceous detrital material and chiefly that derived from the decomposition of the feldspars; indurated clay, sufficiently hardened to be incapable of using as a clay without grinding, but not chemically altered or metamorphosed. (Century) Also called Clay stone.

Clay shale. Shale composed wholly or chiefly of argillaceous material, which again becomes clay on weathering. (La Forge)

Clay slate. An argillaceous rock having a slaty or fissile structure. It differs from clay shale in that it has been altered by metamorphism. (Century)

Clay stone. 1. (Aust.) A soft, earthy, feldspathic rock occurring in veins, and having the appearance of indurated clay. (Power)
2. One of the concretionary masses of clay frequently found in alluvial deposits, in the form of flat rounded disks either simple or variously united so as to give rise to curious shapes. They are sometimes almost as regular as if turned in a lathe. (Century)

Clay-stone porphyry. An old and somewhat indefinite name for those porphyries whose naturally fine groundmass is more or less kaolinized, so as to be soft and earthy, suggesting hardened clay. (Kemp)

Clead (Eng.). To cover with planks. (G. C. Greenwell)

Cleading. A lining or covering of board planks, as the lagging on a winding-engine drum. (Webster)

Clean. 1. (No. of Eng.) Free from fire damp or other noxious gases.
2. A coal seam free from dirt partings. (Gresley)
3. To undergo or perform the process of cleaning; to clean up; to make a clean-up. (Webster)

Cleaner (Scot.). A scraper for cleaning out a shot hole. (Barrowman)

Cleaner cell. A flotation cell in which the concentrates from the rougher cells are again treated for a further reduction in the amount of gangue present.

Cleanser; Clanser (Eng.). An iron tube or shell, with which a bore hole is cleaned. (Gresley)

Cleansing (So. Staff.). Clearing and making fit for traversing old gate roads; carrying out cuttings from the mine; clearing the sumps at bottom of shafts. (Min. Jour.)

Clean toe. A sufficient shattering of the material that constitutes the toe, to make its entire removal possible without excessive secondary blasting. *Compare* Toe, 1 and 2. (Bowles)

Clean-up. 1. The operation of collecting all the valuable product of a given period or operation in a stamp mill, or in a hydraulic or placer mine. (Raymond)
2. The valuable material resulting from a clean-up. (Webster)
3. To load out all the coal a miner has broken. 4. An opportunity to clean up. (Steel)

Clean-up man. 1. Usually a pensioner who keeps yard cleaned up, pulls weeds, and does odd jobs at blast furnaces. (Willcox)
2. The man who performs the operation described under Clean-up, 1.

Cleap. A cleaving crosswise of the bedding in a coal seam; a cleat. (Standard)

Clear. *See* Clean, 1 and 2.

Clearance. 1. The space between the piston at the end of its stroke and the valve face, or the end of the cylinder. (Ihlseng)
2. The space between the top or side of a car and the roof or wall.

Clearer. 1. (Eng.) Miners who undercut the coal, working at distances of say three or four yards apart along the face. (Gresley)
2. A reservoir (in salt making) into which brine is conveyed.

Clear-melting. The process of keeping the glass in a molten condition for a time sufficient to permit the impurities or uncombined substances to settle. (Century)

Cleat. 1. The main set of joints along which coal breaks when mined. (Webster)
2. A small piece of wood nailed to two planks to keep them together, or nailed to any structure to make a support for something else. (Steel)
3. (Mid.) A wooden wedge four or five inches square placed between the top of a post and the underside of a bar or cap. (Gresley)
4. (Eng.) A piece (or pieces) of wood fastened to pump spears for the purpose of steadying them, and preventing them from wearing where they pass through the collaring, and to prevent the edges of the spear plates and bolts from injuring the pumps. (G. C. Greenwell)

Cleavage. 1. In petrology, a tendency to cleave or split along definite, parallel, closely spaced planes, which may be highly inclined to the bedding planes. It is a secondary structure, commonly confined to bedded rocks, is developed by pressure, and ordinarily is accompanied by at least some recrystallization of the rock.
2. In crystallography, the property possessed by many crystalline substances, of being rather easily split parallel to one or more of the crystallographic planes peculiar to the substance (La Forge). Cleavage should not be applied to the fracturing of rocks, which is *jointing*. *See* Jointing.

Cleavage plane. The planes along which the cleavage takes place. *Compare* Joint plane.

Cleave (Scot.). One of two or more divisions of a seam, usually ironstone. (Barrowman)

Cleavings (Eng.). Divisions of beds of coal, in the direction of the laminæ, either horizontal or inclined.

Cleaving way (Corn.). A direction parallel to the bedding planes of a rock. *Compare* Quartering way. (Greenwell, p. 80)

Cleavlandite. A white lamallar variety of albite. (Dana)

Cledge (Eng.). Clay; stiff loam; also the upper stratum of certain beds of fuller's earth. (Webster)

Cleek. 1. (Scot.) To load cages at the shaft bottom or at mid-workings.
2. (Scot.) A haulage clip. (Gresley)

Cleek coal (Scot.). Coal as it comes from the mine (Barrowman). *See also* Run-of-mine.

Cleeksman; Cleekie (Scot.). An early term for the person who unhooked the baskets of coal at the shaft mouth. (Barrowman)

Cleet (Derb.). *See* Cleat, 3.

Cleugh; Cleuch. A cleft or gorge in a hill; a ravine; also a cliff or the side of a ravine. (Century)

Cleve. (Eng.). A steep hillside; a cliff. (Standard)

Cleveite. A variety of urananite containing a large percentage of UO_2, and also rich in helium. Contains about 10 per cent of the yttrium earths. (Dana)

Cliff. 1. (Wales) Shale which is laminated, splitting easily along the planes of deposition. *See also* Bind, 1 (Gresley). Also called Clift.
2. A steep slope; a precipice. (Webster)
3. The strata of rocks above or between coal seams. (Standard)

Cliff glacier. A glacier which occupies a relatively small depression in the side of a mountain or in the escarpment of a plateau. (Century)

Clift. 1. (Eng.) Local term for shale (Redmayne). *See also* Cliff, 1.
2. A cliff (Standard). *See also* Cliff, 2.

Cliftonite. Carbon in minute cubic crystals (Dana). A form of graphitic carbon occurring in cubic or cubo-octahedral crystals in the meteoric iron of Youngdegin, West Australia. (Century)

Clinch, or Clink bolts (Eng.). Cross bolts under spear bolts to prevent the pump rods from stripping. (G. C. Greenwell)

Clinker. 1. The product of the fusion of the earthy impurities (ash) of coal during its combustion. (Raymond)
2. *See* Cinder coal, 1.
3. A partially vitrified brick or mass of bricks. 4. Vitrified or burnt matter thrown up by a volcano. 5. A scale of black oxide of iron formed when iron is heated to redness in open air. (Century)

Clinker bar. A bar fixed across the top of an ash pit for supporting the rods used for clearing the fire bars. (Century)

Clinker brick. A very hard-burned brick. (Ries)

Clinkstone. *See* Phonolite.

Clinoaxis. The diagonal or lateral axis in the monoclinic system which makes an oblique angle with the vertical axis. (Webster)

Clinochlore. A silicate of aluminum and magnesium usually containing iron. Normally, $H_8Mg_5Al_2Si_3O_{18}$. (Dana)

Clinoclase. 1. Oblique cleavage. 2. A basic copper arsenate. *See* Clinoclasite.

Clinoclasite. A hydrous copper arsenate $Cu_3As_2O_8.3Cu(OH)_2$ or $6CuO.As_2O_5.3H_2O$. Color, internally, dark verdigris-green; externally blackish blue-green, and crystallizes in the monoclinic system. (Dana)

Clinometer. A simple apparatus for measuring by means of a pendulum or spirit level and circular scale, vertical angles, particularly dips. (Raymond)

Clinozoisite. An epidote without iron, having the composition of zoisite. (Dana)

Clinton ore. A red, fossiliferous, iron ore of the Clinton formation of the United States, with lenticular grains. Called also Dyestone, Fossil, or Flaxseed ore. (Standard)

Clip. A device similar to a clamp but smaller and for the same purpose (C. M. P.). *See also* Haulage clip.

Clipper (Eng.). A hook for attaching the bucket to the cable. Used in shaft sinking. (Bainbridge)

Clipper-off (Aust.). A boy who unfastens the clip connecting a skip to a haulage rope. (Power)

Clipper-on (Aust.). A boy who fastens skips to a haulage rope with a clip. (Power)

Clip pulley (Eng.). A wheel containing clips in the groove for gripping a wire rope. (Gresley)

Clivage (Peru). Cleavage. (Dwight)

Clive (Derb.). *See* Cliviss.

Cliviss (Eng.). A bit of turned iron, with a spring, for fastening a bucket to a rope (Bainbridge). Also called Clive; Clivvy. A variation of Clevis.

Clivvy (Eng.). *See* Cliviss. A variation of Clevis.

Clod; Clot. 1. Soft shale or slate, in coal mines, usually applied to a layer forming a bad roof. (Raymond)
2. *See* Kettle bottom. A "clod of dirt" of greater or less diameter; thin at the edges and increasing in thickness to the middle. (Missouri & Illinois Coal Co. *v.* Schwalb, 74 Illinois, App., p. 569).

Clod coal (Scot.). Strong homogeneous coal. (Barrowman)

Clod tops (Forest of Dean). Clay or shale beds overlying seams of coal. (Gresley)

Clog (Mid.). A short piece of timber about 3 by 6 by 24 inches fixed between the roof and a prop. (Gresley)

Clog pack (York.). *See* Chock, 1, and Nog, 1.

Clorurar (Mex.). To chloridize. (Dwight)

Close connected. Applied to dredges in which the buckets are each connected to the one in front without any intermediate link. (Weatherbe)

Closed basin. A district draining to some depression or lake within its area, from which water escapes only by evaporation. (Webster)

Closed fault. *See* Fault.

Closed fold. A fold in which the limbs (sides of the arch) have been compressed until they are parallel. (Farrell)

Closed form. A crystal form in which all the faces having a like position relative to the planes, or axes, of symmetry yield an enclosed solid. (Dana)

Closed front. An arrangement of the blast furnace without a forehearth. (Raymond)

Closed season. That portion of the year when placers cannot be worked by reason of shortage of water, due to drought or cold.

Closed top. *See* Cup-and-cone.

Close-grained. Having fine and closely arranged fibers, crystals, or texture. (Webster)

Close-jointed. A term applied to joints that are very near together. (Dale)

Close mold. A two-part flask filled by pouring through ingates. (Standard)

Close place (Scot.). A narrow drift without a separate air return. (Barrowman)

Close-poling. The placing of poles or plank close together. *See also* Poling, 2.

Close work. 1. Driving a tunnel or drifting between two coal seams. 2. (Scot.). *See* Narrow work, 3. (Gresley)

Closing apparatus (Eng.). Sliding-doors or other mechanical arrangement at the top of an upcast shaft for allowing the cages to pass up and down without disturbing the ventilation of the mine. (Gresley)

Clot. Same as Clod.

Clothing (Eng.). Brattice constructed of a coarse, specially prepared canvas. (Gresley)

Cloth oil. A name given to one of the distillates of crude petroleum (specific gravity, 0.875) which is used for oiling wood. (Mitzakis)

Clotting. The sintering or semi-fusion of ores during roasting. (Raymond)

Clour (Eng.). A small depression of roof extending into the coal. (G. C. Greenwell)

Cloustonite. A mineral related to asphalt, occurring in patches in blue limestone and in blue flags at Inganess, Orkney. It is soluble in benzol and at a red heat gives off a large amount of illuminating gas. (Bacon)

Cloy. A plastic cement mixture: applied to any clay not a natural clay. (Standard)

Clucking. The breaking of a rock by curved fractures that pass beyond the limit of the desired plane of separation. (Bowles)

Clumper (Forest of Dean). A large mass of fallen stone. (Gresley)

Clunch (Staff.). An English provincial term for any tough coarse clay. (Power)

Clutch. A coupling for connecting two working parts, as shafts, shaft and pulley, permitting either to be thrown in or out at will, as by moving a lever. (Webster)

Clutch room (Aust.). A chamber, generally underground, in which there are friction clutches that control the different haulage ropes of the various districts. (Power)

Coagulation. The state of a solute in a solvent, or of a colloidal gel, resulting from clotting or curdling; the act of changing to a curd-like condition. (Rickard)

Coak. 1. Same as Coke. 2. Same as Calk. (Standard)

Coal. A carbonaceous substance formed from the remains of vegetation by partial decomposition (U. S. Geol. Surv.) A solid and more or less distinctly stratified carbonaceous substance varying in color from dark-brown to black, brittle, combustible, and used as a fuel; not fusible without decomposition and very insoluble. In its formation the vegetal matter appears to have first taken the form of peat, then lignite, and finally bituminous coal. The latter by the loss of its bitumen has in some places been converted into anthracite or hard coal. Lignite gives a brown powder, coal a black. Lignites contain a large percentage of water and ash.

Coal apple (Aust.). A spheroidal form of coal occasionally found in certain seams. (Power)

Coal backer (Eng.). A man who is engaged in carrying coal on his back from a ship to wagons. (Century)

Coal balls (Lanc.). Calcareo-carbonaceous nodules, formed by the infiltration of water carrying calcium carbonate from the shells of an overlying shale, down into the bed of woody fragments where it segregates. (Power)

Coal barge. A barge or lighter used in the transportation of coal by water. (Century)

Coal basin. Depressions in the older rock formations, in which coal-bearing strata have been deposited. (Thompson)

Coal bearer (Scot.). *See* Bearers, 1.

Coal bearing (Scot.). The ancient custom of employing women to carry coal out of the mine. (Gresley)

Coal bed. A bed or stratum of coal. Coal seam is more commonly used in the United States and Canada. (Century)

Coal blacking. Iron founders' blacking made from powdered coal. (Webster)

Coal box (Aust.). Large bins for storing coal. (Power)

Coal brass. Iron pyrite in coal seams (Gresley). Commonly used in the plural.

Coal breaker. 1. A building containing the machinery for breaking coal with toothed rolls, sizing it with sieves, and cleaning it for market. (Raymond)
2. A machine for breaking coal.
3. A person employed to break coal. (Standard)

Coal bunker. A place for storing coal, especially in steamships for furnace use.

Coal car. A freight car designed especially for carrying coal, usually made of iron, with a drop bottom.

Coal carrier. One who or that which is employed carrying coal (Century). A railroad is a coal carrier.

Coal chute. A trough or spout down which coal slides from a bin or pocket to a locomotive tender, or to vessels, carts, or cars. (Century)

Coal clay. *See* Fire clay.

Coal-cutting machine. A machine worked by compressed air or electricity, for undercutting or channeling a bed of coal.

Coal digger. *See* Coal miner.

Coal drawing (Eng.). The operation of raising coal at a colliery. Hoisting. (Gresley)

Coal drop. A broad, shallow inclined trough down which coal is discharged from a wharf into the hold of a vessel. (Century). A coal chute.

Coal duns (Forest of Dean). Coal-measure shales. (Gresley)

Coal dust. A finely divided coal. There is a diversity of opinion as to what the term "coal dust" means; that is, how finely must coal be divided to be termed dust. Some writers base the distinction on the point whether it can be carried to considerable distances by air currents. Coal that will pass through 100-mesh screens (100 wires to the linear inch) is frequently accepted as representing mine dust. For testing explosives at the Pittsburgh station coal passed through 100-mesh is taken as standard. In the foreign galleries the practice varies between this size and coal that passes through 200-mesh.

For the consideration of coal dust as it affects mining, the writer proposes tentatively a definition based on the capacity of the dust to propagate flame in the incipient stages of an explosion, as determined at the Pittsburgh station under certain specific conditions. By this definition, coal particles passing through a 20-mesh wire sieve (20 wires to the linear inch) will be termed dust. In the Pittsburgh gallery-tests, only partial flame propagation was obtained under the prescribed conditions with coal that passed through the 20-mesh and remained on a 40-mesh sieve, but the partial propagation was sufficient to indicate that under slightly more severe conditions, namely, a larger initiating charge of black powder, the propagation might be complete. (Geo. S. Rice, Bull. 20, U. S. Bur. Mines, p. 33.) This view was strengthened by subsequent large-scale tests in the Experimental mine, operated by the U. S. Bureau of Mines, near Pittsburgh, Pa.

Coaler. 1. Anything wholly or chiefly employed in transporting or supplying coal, as a railway from coal-mining regions; also a person employed in coaling vessels. (Webster)
2. *See* Coalers.

Coalers (Colloq., U. S.). A financial term for the stocks of the anthracite coal-carrying railroads. (Standard)

Coalescent. Joined together; running together. (Emmons)

Coalette. A synonym for Briquet.

Coal exchange. A market for the sale of coal; especially a place for transactions in coal on a large scale. (Century)

Coal face. The working face of a stall or room, composed wholly of coal. (Gresley)

Coal factor. *See* Factor.

Coal fauld (Scot.). A storage place for coal. (Century)

Coal field. A region in which deposits of coal occur. Also called Coal basin when of basin-like structure. (Webster)

Coal fitter (Eng.). A coal factor (Standard). *See also* Factor.

Coal formation. A term generally understood to mean the same as the coal measures. (Davies)

Coal gas. Gas made from coal by distilling bituminous coal in retorts, and used for lighting and heating. (Webster)

Coal getter (Eng.). One who cuts, holes, hews, or mines coal in the mine (Gresley). A coal miner.

Coal hagger (No. of Eng.). One who is employed in cutting or hewing coal in the mine (Gresley). A coal miner.

Coal heaver. One employed in moving or shoveling of coal, in loading or discharging coal ships, in shoveling coal from ships' bunkers to the furnaces; a coal passer. (Century)

Coalheugh. 1. (Scot.) A mound of refuse about old mines. (Gresley) 2. (Scot.) A place where coal is dug; a coal mine. (Barrowman)

Coal hewer (Eng.). A person who digs coal; a collier; a miner. (Barrowman)

Coal hill (Scot.). Ground occupied at a pithead or mine mouth for colliery purposes. (Barrowman)

Coal hole. A hole for coal as a trap or opening in a sidewalk; a compartment for storing coal. (Webster)

Coal hulk. A vesel kept, usually at foreign stations for supplying steamers with coal. (Century)

Coaling. 1. The process of supplying or taking coal for use as in coaling a steamer, etc. (Century) 2. (Mid.). Engaged in mining coal. (Gresley)

Coalition. 1. A voluntary joining of persons or parties, for the purpose of combining their resources, as in the support of some plan or policy relating to mining operations; a combination.

Coal land. Land of the public domain which contains coal beds. (U. S. Min. Stat., pp. 724-750)

Coal master (Eng.). The owner or lessee of a coalfield or colliery. (Gresley)

Coal measures. Those strata of the Carboniferous system which contain coal.

Coal metals (Scot.). Strata in which coal seams occur. (Barrowman)

Coal meter (Eng.). One appointed to superintend the measuring of coal. (Century)

Coal mine. Any and all parts of the property of a mining plant, on the surface or underground, which contributes, directly or indirectly under one management to the mining or handling of coal. (Spring Valley Coal Co. v. Greig, 226 Illinois, p. 516; Hakason v. La Salle County Carbon Coal Co., 265 Illinois p. 167.) A colliery. *See also* Mine.

Coal miner. One who digs coal. (Roy. Com.)

Coal oil. 1. The crude oil obtained by the destructive distillation of bituminous coal. 2. That distillate obtained from such a crude oil which is used for illuminating purposes—kerosene. 3. Crude petroleum. (Bacon)

Coal passer. One whose duty it is to pass coal to the furnace of a steam engine. (Century)

Coal pipe (Eng.). 1. The carbonized annular coating or bark of a fossil plant. 2. A very thin seam of coal. *See also* Coal shed. (Gresley)

Coal pit. 1. (U. S.) A place where charcoal is made. 2. (Eng.). A place where coal is dug. A coal mine.

Coal plant. A fossil plant found in association with or contributing by its substance to the formation of coal beds. Strictly speaking, any plant species, the residue of whose individuals has entered under natural geological conditions, into the composition of coal. (Century)

Coal pocket. A structure for the storage of coal. (Century)

Coal prints (No. of Eng.). Thin films, or patches, of coal-like matter interbedded with shale. (Gresley)

Coal puncher; Pick machine. A coal cutter of the reciprocating type, used for undercutting and nicking coal. (Power)

Coal rake (Derb.). A seam or bed of coal. (Gresley)

Coal ree (Scot.). Same as Coal rith.

Coal rith; Coal ree; Coal fauld (Scot.) A sale place for coal other than at a colliery. (Barrowman)

Coal road. 1. An underground roadway or heading in coal. (C. and M. M. P.)
2. A railroad whose principal business is the haulage of coal, as from mine to industrial centers.

Coal room (Scot.). A working face in stoop-and-room workings. (Barrowman)

Coal salad (Wales). A mixture of various sorts of coal. (Gresley)

Coal seam. *See* Coal bed.

Coal seat. Same as Fire clay.

Coal shed (Eng.). A coal bed of only a few inches in thickness, and therefore unworkable. (Gresley)

Coal-sheugh. *See* Sheugh, 2.

Coal smits (York). Worthless, earthy coal. *See also* Coal smut. (Gresley)

Coal smut (Eng.). An earthy coal stratum at or near the surface. The outcrop of a coal seam (Gresley). Also called Blossom of coal.

Coal stone (Eng.). A kind of cannel coal. (Gresley)

Coal tar. A tar obtained by the destructive distillation of soft or bituminous coal, as in the manufacture of coal gas. It is a complex mixture of hydrocarbons and other substances. It is the source of many dyestuffs. (Webster)

Coal-tar naphtha. The light oil produced in the distillation of coal tar. (Bacon)

Coal-tar pitch. The residuum from the distillation of coal tar. Most of the tar is run to soft pitch with a melting point between 60° and 80° C. (Bacon)

Coal trimmer. One who is employed to stow and trim or shift coal on board vessels, either as cargo or supply for furnaces. (Century)

Coal vend. 1. (Eng.). The general sale of coal. 2. The limited quantity of coal to which each colliery was restricted by a former combination of coal operators on the Tyne. (Century)

Coal wall (Scot.). The coal face. (Barrowman)

Coal warrant (Wales). A kind of fireclay forming the floor of a coal bed. (Gresley)

Coal washery. *See* Washery.

Coal washing. *See* Washing apparatus.

Coal whipper. A laborer or a machine that raises coal out of the hold of a ship. (Webster)

Coal work. 1. (No. of Eng.). Headings driven in coal. (Gresley)
2. (Scot.). A colliery. (Barrowman)

Coal workings. A coal mine with its appurtenances; a colliery (Standard). Coal works.

Coaly rashings. Soft dark shale, in small pieces, containing much carbonaceous matter. (C. and M. M. P.)

Coarse; Coose. A name given to a vein or the material from it when it is not rich, the mineral being only thinly disseminated through it (Power). Inferior, faulty.

Coarse jigs. The jigs used to handle the larger sizes and heavier grades of ore or metal. (Weed)

Coarse lode. One not rich. *See also* Coarse. (Skinner)

Coarse metal. The regulus or copper matte obtained when smelting copper ore, containing 20 to 40 per cent copper. (Webster)

Coarse roll. A large roll for the preliminary crushing of large pieces of ore, rock, or coal. Used in stage crushing.

Coast and Geodetic Survey. A bureau of the United States Government charged with the topographic and hydrographic survey of the coast and the execution of belts of primary triangulation, and lines of precise leveling in the interior.

Coaster (Corn.). One who picks ore from the dump or abandoned mines. (Crofutt)

Coave. A sled for transporting coal in mines. (Daddow)

Cob. 1. (Corn.) To break ore with hammers, so as to sort out the valuable portion. (Whitney)
2. (Derb.) A small, solid pillar of coal left as a support for the roof. (Gresley)

Cobalt. A tough, lustrous, nickel-white metal, related to and occurring with iron and nickel. Symbol, Co; atomic weight, 58.97. Specific gravity, 8.6.

Cobalt bloom. *See* Erythrite.

Cobalt glance. *See* Cobaltite.

Cobaltina (Mex.). Cobaltite. (Dwight)

Cobaltite. A sulpharsenide of cobalt, CoAsS. Contains 35.5 per cent of cobalt. Cobalt glance. (U. S. Geol. Surv.)

Cobalt minerals. Minerals containing cobalt as linnaeite, cobaltite; erythrite; smaltite.

Cobalt ocher. The mineral erythrite. (Standard)

Cobalt pyrites. *See* Linnaeite.

Cobalt vitriol. *See* Red or Rose vitriol.

Cobbed ore (Eng.). Ore broken from veinstone by means of a small hammer. (Hunt)

Cobbing. 1. (Corn.) Breaking ore to sort out its better portions. *See also* Spall. (Raymond)
2. Rubble, as from furnace bottoms, impregnated with copper. (Standard)

Cobbing board. A flat piece of wood used in cobbing. (Century)

Cobbing hammer. A short double-ended hammer for breaking minerals to sizes. (C. and M. M. P.)

Cobble. 1. (Penn.) In metallurgy of iron, an imperfectly puddled ball which goes to pieces in the squeezer. (Raymond)
2. (Eng.) Small lump coal. (Gresley). *See also* Cob coal.
3. *See* Cobblestones.

Cobblestone. A smoothly rounded stone, larger than a pebble and smaller than a bowlder. (La Forge)

Cobbling (Eng.). Cleaning the haulage road of coal which has fallen off the trams. (Gresley)

Cobcoal. A large round piece of coal. (Century)

Cobre (Sp.). Copper; *C. abigarrado*, bornite; *C. amarillo*, chalcopyrite; *C. azul*, azurite; *C. gris*, gray copper, tetrahedrite; *C. negro*, black or blister-copper; *C. roseta*, rose-copper, ingot-copper; *C. rojo*, red oxide of copper; *C. verde*, malachite; *C. virgen*, native copper. (Halse)

Cobrizo (Sp.). Coppery; cupreous; copper-bearing. (Halse)

Cob wall. A wall built of unburned clay, sometimes mixed with straw, or of straw, lime, and earth. (Century)

Cocarde ore. *See* Sphere-ore.

Coccolith. A minute calcareous body found in chalk and deep-sea ooze. It is supposed to be the secretion of a unicellular plant. (Webster)

Cocer (Sp.). To burn lime; to roast ore. (Halse)

Cocha (Peru). A settling tank (Pfordte). Also a lenticular ore deposit. (Halse)

Cochano (Venez.). A nugget. (Halse)

Coche; Cochina (Mex.). A rock-crusher; a large anvil. (Dwight)

Cochizo (Peru). Gray copper-ore. (Dwight)

Cockade ore. Cockscomb pyrite; a form of marcasite. (Power)

Cockermegs (Eng.). Timber props to support the coal while undercutting (Gresley). *Also* called Cockers.

Cockerpole. A piece of timber placed horizontally between two inclined pieces which abut against the roof and floor. (Gresley)

Cockers. *See* Cockermegs.

Cockerspraggs. Same as Cockermegs.

Cockhead (Derb.). A pack to support the roof. It consists of slack or waste and is about 12 ft. in width, surmounted by a few lumps of coal. (Gresley)

Cockle. 1. (Corn.) Schorl or black tourmaline. (Whitney)
2. Any mineral occurring in dark, long crystals, especially black tourmaline or schorl. (Webster)

Cock metal. A soft alloy composed of two parts copper and one part lead. Used for making taps and cocks. (Century)

Cockschute (Welsh). Hard siliceous beds passing into conglomerates in the Coal Measures of South Wales. (Power)

Cockscomb pyrites. A variety of marcasite occurring in crestlike forms. (Webster)

Coco (Colom.). A cocoanut vessel in which to deposit auriferous sands. (Halse)

Cod (Newc.). The bearing of an axle. (Raymond)

Code. 1. A unified and coordinated body of law; especially, reenactment, in improved and systematic form, of previously existing law, whether derived from statute, prescription, or judicial decisions. 2. A system of signals or of characters used to represent letters or words, or in any way to communicate intelligence, as a cipher code, naval code, telegraphic code. *See* Telegraph. 3. A system of rules and regulations generally approved and formally applied for conduct in particular cases; as, the social code; the code of honor; the mining code. (Standard)

Código (Sp). Code of laws; *C. de minas*, mining code; law of mines. (Halse)

Cod piece (Aust.). A wooden fishplate used for connecting the segments of a curb in shafts. (Power)

Coe (Eng.). A small cabin built over the shaft. (Hunt)

Coefficient. In physics, a number commonly used in computation as a factor, expressing the amount of some change or effect under certain conditions as to temperature, length, time, volume, etc., as the coefficient of contraction, depression, discharge, displacement, efficiency, efflux, elasticity, expansion, fineness, friction, hysteresis, inertia, leakage, mobility, reduction, refraction, resistance, rigidity, safety, and velocity. (Webster)

Coestead (Eng.). A small building. *See* Coe. (Bainbridge)

Coffee-pot lamp (Aust.). An ordinary coal miner's open oil lamp, similar in shape to a coffee pot.

Coffer; Cofer. 1. (Derb.). To secure a shaft from leaking by ramming in clay behind the masonry or timbering. 2. (Corn.). *See* Mortar, 2. 3. A rectangular plank frame, used in timbering levels. (Raymond)
4. A floating dock; a caisson. (Standard)

Cofferdam. 1. A water-tight inclosure, as of piles packed with clay, from which the water is pumped to expose the bottom (of a river, etc.) and permit the laying of foundations, building of piers, dams, etc. (Webster)
2. A double bulkhead, provided in tank steamers for the purpose of isolating the oil cargo from the engine and boiler space or from holds used for other cargo, and to prevent leakage into the adjacent compartments. (Mitzakis)

Coffering. The operation of securing the shaft of a mine from the ingress of water by ramming clay in between the casing and the rock. (Century)

Coffin (Corn.). An old open-mine working, in which the ore is cast up from platform to platform. (Standard)

Cog. 1. A rock intrusion. 2. To consolidate as by hammering or rolling; also to shape by rolling and re-rolling, as in the manufacture of iron. (Webster)
3. *See* Cogs; Chock; Nog.

Cog-and-rung gin. One of the earliest appliances for hoisting the coal and water from the mine. It was a windlass fitted with a cogwheel and pinion arrangement, and worked by a horse in much the same way as horse-gins are worked. (Gresley)

Cogedor (Sp.). A collector; a sampler. (Halse)

Cogger (Eng.). One who builds cogs (Gresley). *See* Cogs.

Cogging; Coggin (So. Staff.). The propping of the roof in longwall stalls. (Gresley). *See also* Cogs; Nogs.

Cogollos (Colom.). The superficial part of an ore deposit; *C. de las vetas*, an outcrop. (Halse)

Cogs. *See* Nogs; only cogs are not squared, but simply notched where they cross each other. The interior of a structure of this kind and the spaces between the timber are usually filled with gob. They are called also Cobs, Corncobs, etc. (Raymond)

Cohesion. That force by which molecules of the same kind or of the same body are held together, so that the body resists being pulled to pieces. (Rickard)

Cohetaso (Mex.). A shot with a match, squib or detonator inserted. (Halse)

Cohete (Mex.). A blasting cartridge, a rocket; applied to a blast within a mine or outside. (C. and M. M. P.)

Coil drag. A tool to pick up pebbles, bits of iron, etc., from the bottom of a drill hole. (Raymond)

Coin silver (U. S.). The alloy of silver and copper which in the United States is accepted as the legal standard of fineness for the silver coinage, counting 90 per cent of the former metal to 10 per cent of the latter. (Standard)

Coir. Cocoanut-husk fiber (C. and M. M. P.) Used in certain metallurgical processes.

Cok (Mex.) Coke. (Dwight)

Coke. Bituminous coal from which the volatile constituents have been driven off by heat, so that the fixed carbon and the ash are fused together. Commonly artificial, but natural coke is also known. (U. S. Geol. Surv.)

Coke coal (No. of Eng.). Carbonized or partially burnt coal found on the sides of dikes (Gresley). *See also* Natural coke.

Coke drawer. A mechanical device for drawing coke from an oven. (Fulton, p. 187)

Coke iron. Iron made in a furnace using coke as a fuel. (Webster)

Coke oven. An oven used in the manufacture of coke. *See* Beehive oven; *also* By-product oven. Webster)

Coke-oven tar. Coal tar produced in by-product coke ovens in the manufacture of coke from bituminous coal. (Bacon)

Coke plate. Coke-smelted or puddled-iron coated with tin (Standard). *See also* Tin plate.

Coke scrubber. An apparatus filled with coke moistened with oil, used to purify street gas, which is forced through it. (Century)

Coke tower. A high tower or condenser filled with coke, used in the manufacture of hydrochloric acid to give a large surface for the union of a falling spray of water with the rising hydrochloric acid gas. (Century)

Coke wharf (Aust.). A platform onto which coke is pushed when discharged from an oven. (Power)

Cokey (Joplin, Mo.). A shoveler; a mucker.

Cokey herder (Joplin, Mo.). A foreman of a shovel gang.

Coking coal. The most important of the bituminous coals, which burns with a long yellow flame, giving off more or less smoke, and creates an intense heat when properly attended. It is usually quite soft, and does not bear handling well. In the fire it swells, fuses, and finally runs together in large masses, which are rendered more or less porous by the evolution of the contained gaseous hydrocarbons. (Chance)

Coking plate. A plate at the door of a furnace which uses bituminous coal, on which fresh coal is placed and allowed to coke before being spread on the fire. (Century)

Coking stoker. A mechanical stoker or device for firing a furnace which permits the coal to coke before feeding it to the grate, thus burning the fuel with little or no smoke. (Century)

Col (Fr.). A saddle or gap across a ridge or between two peaks; also, in a valley in which streams flow both ways from a divide, that part of the valley at the divide, especially if the valley slopes rather steeply away from the divide. (La Forge)

Cola. 1. (Mex.) That part of a vein which terminates in depth; tail-end of a vein. 2. (Colom.) The lower end of a placer mine. The lower end of a ground sluice. 3. (Sp.) The bottom layer of slag below the charge in a smelting furnace. (Halse)

Coladera (Mex.). A coarse screen. (Dwight)

Coladero. 1. (Sp.) A winze. 2. (Colom.) Any chute or pass for ore. (Halse)

Colander shovel. An open wirework shovel used for taking salt crystals from an evaporating brine. (Century)

Colas (Sp.). Tailings from a stamp mill or any wet process. (C. and M. M. P.)

Cold bed. A platform in a rolling mill on which cold bars are stored. (Raymond)

Cold blast. Air forced into a furnace without being previously heated (Raymond). *See* Gayley process.

Cold chisel. A chisel of tempered steel, used in cutting cold metal. (Standard)

Cold-drawn. Drawn while cold or without the application of heat, as cold-drawn steel tubing. (Webster)

Cold furnace (No. of Eng.). A drift driven into an upcast shaft to convey the return air into it instead of passing it over the furnace fire. This is done to prevent the ignition of the gas in the return air. (Gresley)

Cold nose. (Western U. S.). A mining expert who underrates the value of mineral properties. (Standard)

Cold pit (Leic.). A downcast shaft. Called cold because the fresh or cold air comes down it. (Gresley)

Cold-roll. To roll while cold or without the application of heat. (Webster)

Cold-short. Brittle when cold; applied chiefly to iron and steel (Raymond). *Compare* Red-short.

Cold-shot. 1. Small round particles of iron sometimes found in the chilled part of an iron casting. (Standard)
2. Chilled by the mold in casting, or imperfect through such chilling. (Webster)

Cold-stoking. In glass making, the operation of lowering the temperature of the oven until the glass attains the proper consistency for blowing. This operation follows that of clearing. (Century)

Cold test. A name given to a test applied to lubricating oils in order to ascertain their power of withstanding low temperatures without solidifying or depositing paraffin. (Mitzakis)

Colemanite. A hydrous borate of calcium, $2CaO . 3B_2O_3 . 5H_2O$. The commonest source of borax in the United States. (U. S. Geol. Surv.)

Colero (Mex.). A boss in charge of *peones*. (Dwight)

Colgantes (Mex.). Hangers for suspending sets in shafts. (Halse)

Colgar el canalón (Sp. Am.). To prepare the sluice for washing; *C. el mineral*, to open a vein by driving levels; *metal colgado*, ore in sight; ore reserves. (Halse)

Colina (Mex.). A small hill. (Dwight)

Colindantes (Mex.). Neighboring mining properties, not more than 100 meters apart. (Dwight)

Collado (Sp.). A hill. (Min. Jour.)

Collar. 1. *See* Cap. 2. The collar of a shaft is the horizontal timbering around the mouth. (Raymond)
3. (No. of Eng.) The mouth of a mine-shaft. (Gresley)
4. The mouth or opening of a bore hole. (Du Pont)
5. A flat ring surrounding anything closely. (Steel)
6. (Scot.) A frame to guide pump rods; the fastening of pipes in a shaft. (Barrowman)

Collar crib (No. of Eng.). A strong polygonal wooden frame fixed in a shaft, upon which the crib or wood tubbing is bedded. (Gresley)

Collared. Designating a drill hole in rock when the hole has gained sufficient depth to hold the drill from slipping. (Gillette, p. 120)

Collaring (Eng.). Timber framing for supporting pump trees in a shaft. *See also* Chogs. (Gresley)

Collar launder (Eng.). The pipe at the top of a lift of pumps for carrying water to a cistern. (Bainbridge)

Collar of shaft (Aust.). The first wooden frame round the top of a shaft (Power). *See* Collar, 2 and 3.

Collecting rope (Aust.). An endless rope used for bringing skips from where they are left by the main haulage system to the bottom of the shaft. (Power)

Collier (Eng.). 1. Strictly speaking a man who mines coal with a pick though commonly applied to anyone who works in or about a colliery.
2. A steam or sailing vessel carrying a cargo of coal. (Gresley)
3. A coal merchant or dealer in coal. (Century)

Collier's coal. A certain weight of coal allowed periodically (once in a month or six weeks) by the owners to the men employed on the works. (Gresley)

Collier's lung. *See* Anthracosis.

Collier's ton (Eng.). A weight of often several cwt. in addition to the standard ton of 2,240 lbs. In former times as much as 28 cwt. was reckoned as one ton. (Gresley)

Colliery (Eng.). 1. A place where coal is mined, including its machinery and plant (Gresley). *See also* Coal mine.
2. The coal trade. (Standard)

Colliery bailiff (Derb). The superintendent of the colliery. (Min. Jour.)

Colliery consumption. The amount of fuel consumed in generating steam and for other purposes in and about a colliery. (Gresley)

Colliery warnings (Eng.). Telegraphic messages sent from signal-service stations to the principal colliery centers to warn managers of mines when sudden falls of the barometer occur. (C. and M. M. P.)

Collimate. 1. To bring into line, as the axes of two lenses or of two telescopes; also to make parallel, as refracted or reflected rays. 2. To determine or correct the direction of the line of sight (of a telescope) by use of a collimator, or by vertical reflection from the surface of a basin of mercury. (Standard)

Collimation axis. The straight line passing through the optical center of the object glass (of a transit) and the horizontal rotation axis perpendicular to the latter. (Webster)

Collimation plane. The plane described by the collimation axis during the revolution of a transit. (Webster)

Collimator. A fixed telescope with spider-lines in its focus, used to adjust a second telescope by looking through it in a reverse direction with the latter, so that images of the spider-lines are formed in the focus of the second telescope, as if they originated in a distant point. (Standard)

Collision waves. Two waves that are propagated in opposite directions through the burned gases, and originating at the point where two explosion waves meet. (Mellor, Chemical Statistics and Dynamics, p. 491. 1909)

Collodion. A solution of gun-cotton in ether and alcohol. It is deposited as a film on the evaporation of the ether, and is used as a coating for wounds and for photographic plates. (Standard)

Colloid. A state of matter supposed to represent a degree of subdivision into almost molecular dimensions, dispersed in a solvent. Colloidal particles possess the property of carrying electric charges, and also of failing to diffuse through a membrane, this being the original distinction between colloids and crystalloids. (Rickard)

Collom washer (Lake Sup.). A variety of jig. (Raymond)

Collophanite. A dull, colorless or snow-white hydrous calcium phosphate, $Ca_3P_2O_8+H_2O$. (Dana)

Colluvial. Consisting of alluvium in part and also containing angular fragments of the original rocks. Contrasted with Alluvial and Diluvial. (Century). Also, talus and cliff débris; material of avalanches. (Watson, p. 241)

Cologne earth. An earthy, peaty mass of lignite, or partly fossilized wood, of a deep brown color, occurring in an irregular bed of from 30 to 50 feet thick, near Cologne. (Page)

Cololite. In geology, a substance appearing to be the petrified intestines of fishes or their contents, but more probably formed of worm casts. Frequently found in the lithographic slates of the Oölite. (Century)

Colophonite. A coarse garnet of the variety andradite. So called by reason of its resinous luster and color. (Dana)

Color (Sp.). 1. Color. The shade or tint of the earth or rock which indicates ore. 2. A particle of metallic gold found in the prospector's pan after a sample of earth or crushed rock has been "panned out." Prospectors say, *e. g.*, "The dirt gave me so many colors to the panful." (Raymond)

Coloradoite. A native telluride of mercury, found in Colorado. (Century)

Colorados. 1. (Sp.). Ores impregnated with oxide of iron, and in a state of decomposition. *See also* Gossan. (Raymond)
2. (Mex.). The region of a mineral vein which includes the oxidized portion. (Dwight)
3. (Peru and Chile). Oxidized silver ores colored by copper or in which malachite or azurite predominates. (Halse)

Colors (Interference). In optical mineralogy, the colors of doubly refracting substances as seen in polarized light. (A. F. Rogers)

Colote (Mex.). A special basket used for handling earth, etc., by *cargadores;* is slung on the back, and usually provided with a short tail-rope for quick dumping. (Dwight)

Colpa. 1. (Peru) Iron sulphate. 2. (Mex.) A natural mixture of sulphate and peroxide of iron (Colcothar) in the *patio* process, and sometimes used in lieu of *magistral.* (Halse)
3. (Peru) An ore containing galena, tetrahedrite and native silver (Dwight). Any mixture of ores for smelting purposes.

Colpas (Chile). Lump-ore. (Dwight)

Colrake. A shovel used to stir lead ores during washing. (Raymond)

Columbia group. A series of fluvioglacial marine and estuarial deposits of sand and gravel, overlying the Lafayette formation along the Atlantic coast of the United States south of New York, formed in the Pleistocene during the final glacial retreat.

Columbite. A variable columbate and tantalate of iron and manganese containing preponderant columbium and grading into tantalite, in which tantalum preponderates. (U. S. Geol. Surv.)

Columbium. A metallic element of steel-gray color and brilliant luster. Tantalum, which it closely resembles chemically, is usually associated with it. Symbol, Cb; atomic weight, 93.1. Specific gravity, 7.06 to 8.4. (Webster)

Column. 1. The rising main or length of pipe conveying the water from the mine to the surface. 2. *See* Motive column. 3. A solid core cut from a bore-hole. (Gresley)
4. A kind of supporting pillar. (Webster)
5. The water above the valve in a set of pumps. (Greenwell)

Columna (Mex.). A standard for a cable-tramway; column; vertical damper. (Dwight)

Columnar structure. 1. A mineralogical structure made up of slender columns, as in some amphibole. 2. A structure common in dikes, sills, and lava sheets, consisting of parallel, more or less regular, prismatic columns, generally transverse to the rock [illegible]. (La Forge)

Column pipe. The large cast-iron (or wooden) pipe through which the water is conveyed from the mine pumps to the surface (Chance). A mounting pipe; a rising main.

Columns-of-ore. Deposits of ore in lodes having a small lateral, but considerable vertical extent (Duryee). An ore-shoot.

Comagmatic. Having certain chemical or mineral characters in common and hence regarded as derived from a common parent magma; consanguineous; said of igneous rocks in a district or region, but not necessarily including all igneous rocks of the district. (La Forge)

Comagmatic region. An area in which the igneous rocks of the same general geologic age have certain distinguishing characters in common and are regarded as comagmatic; a petrographic province. (La Forge)

Comalillo. 1. (Mex.). A damper in a furnace-flue. (Dwight)
2. A double-hearthed reverberatory furnace for making *magistral.* (Halse)

Comanche series. The Lower Cretaceous series of limestones covering nearly all Mexico, and most of Texas. (Standard)

Comb. The place, in a fissure which has been filled by successive depositions of mineral on the walls, where the two sets of layers thus deposited approach most nearly or meet, closing the fissure and exhibiting either a drusy central cavity, or an interlocking of crystals. (Raymond)

Combed veins. *See* Banded veins; *also* Comb.

Combination gas. Natural gas rich in oil vapors. Wet gas. Also called Casing-head gas.

Combination longwall. *See* Longwall method.

Combination of subslicing and stoping. *See* Sublevel stoping.

Combination shot. A blast made by dynamite and permissibles or permissible explosives and blasting powder in the same hole. It is bad practice and in many States is prohibited by law. (Du Pont)

Combination stoping. *See* Combined and underhand stoping.

Combined carbon. That portion of the carbon in iron or steel which is not visible as graphite, and is supposed to be alloyed or chemically combined with the iron. (Raymond)

Combined overhand and underhand stoping. This term signifies the workings of a block simultaneously from the bottom to its top and from the top to the bottom. The modifications are distinguished by the support used—open stopes, stull-supported stopes or pillar-supported

stopes (Young). Also known as Combined stopes, Combination stoping, Overhand stoping and milling system, and Back and underhand stoping milling system.

Combined shrinkage stoping and block caving. Also called Overhand stoping with shrinkage and simultaneous caving. In this method the orebody is worked from the top down in successive layers of much greater thickness than in top slicing. The mass of ore is weakened by a series of shrinkage stopes, which are extended up between the ribs, pillars, or blocks, which are subsequently caved. The intervening blocks are undercut and caved as in block caving. The cover follows the caved ore. (Young)

Combined side and longwall stoping. *See* Overhand stoping.

Combined stopes. *See* Combined and underhand stoping.

Combined top slicing and shrinkage stoping. In this method the orebody is worked from the top down in successive slices. In the working of each slice the unit is worked as a shrinkage stope. The broken ore serves to give lateral support to the sides of the unit and also serves as a working platform from which the back is reached. After working a unit the cover is caved. No timber mat is used. (Young.) Also known as the Kimberly method.

Combining weight. That proportional weight, referred to some standard, and for each element fixed and exact, by which an element unites with another to form a distinct compound. The combining weights are either identical with, or are some multiples or submultiples of, the atomic weight. (Webster)

Combo (Peru). A sledge for breaking ore. (Halse)

Combustible. Capable of undergoing combustion; inflammable. (Webster)

Combustible shale. A synonym for Tasmanite.

Combustion. The action of fire on inflammable materials; the act or process of burning. Chemically considered, it is a process of rapid oxidation caused by the union of the oxygen of the air, which is the supporter of combustion, with any material that is capable of oxidation. (Century)

Combustion chamber. A space over or in front of furnace where the gases from the fire become more thoroughly mixed and burnt. (Webster)

Combustion furnace. A long, narrow, portable furnace used in the combustion method. (Webster)

Combustion method. A method for the quantitative determination of carbon, hydrogen, etc., by combustion of the substance with air, oxygen, or some solid oxidizing material as copper oxide, and absorption or collection of gaseous products. It is extensively used for the analysis of organic compounds, and also for the determination of carbon in iron and steel. (Webster)

Combustion tube. A tube capable of standing considerable heat, used in the combustion method. (Webster)

Come-along. A gripping device as for stretching wire, consisting of two jaws so attached to a ring that they are closed by putting on the ring. (Webster)

Comendite. A variety of rhyolite, containing phenocrysts of sanidine, quartz, and aegirite, in a granophyric and spherulitic groundmass containing hornblende and some blue soda-amphibole, together with zircon, magnetite, titanite, tridymite, and plagioclase. The name was given by Bertolis, an Italian geologist, from a locality on the island of San Pietro, Sardinia. *Compare* Paisonite. (Kemp)

Comer (Mex.). To eat; *C. Alevanto*, to break or stope ore; *Comer los pilares*, to take out the last vestiges of mineral from sides and pillars of a mine; to rob pillars. (Dwight)

Comerse los pilares (Sp.). The same as *comer los pilares*, figuratively, to abandon a mine. (Min. Jour.)

Comet (Wales). A hand lamp with a long, torchlike flame. (Gresley)

Come water. The constant or regular flow of water in a mine proceeding from old workings or from water-bearing rocks. (Gresley)

Comilio (Sp.). A reverberatory furnace. (Min. Jour.)

Coming up to grass; Coming up to day. (Eng.). A common term used by miners for the word basset, or outcrop. (Gresley)

Comminute. To reduce to minute particles, or to a fine powder; to pulverize; triturate. (Webster)

Common iron. The poorest quality of commercial iron. (Standard)

Communication road (Scot.). An underground road between two coal mine shafts. (Barrowman)

Commutator. 1. A device for reversing the direction of an electric current, as through the primary circuit of an induction coil. 2. An attachment for the armature of a dynamo for commutating or rectifying the induced currents in the armature conductors. (Webster)

Commuting transformer. A transformer resembling a dynamo but with a revolving commutator, the other parts being stationary (Webster)

Como beds. In geology, a thin series of beds extending from Wyoming along the east base of the Rocky Mountains into Colorado, containing a rich land fauna of mammals and reptiles. They are referred either to the Upper Jurassic or Lower Cretaceous. (Standard)

Compact. Closely or firmly united or packed; solid; dense; as a compact texture in rocks. (Webster)

Company. 1. (Eng.) A number of butty colliers, or partners who work in a stall or room. (Gresley)
2. An association of persons for a joint purpose, especially for carrying on a commercial or industrial enterprise. (Webster)

Company man. A man who works for the company by the hour or by the day, such as track layers, timbermen, drivers, and cagers, as distinguished from miners who work under contract, as by the ton, yard, etc. He also brushes down the walls and roof when apparently dangerous; loads the loose rock and débris into cars and pushes them out to the haulage way. (Spring Valley Coal Co. *v.* Chiaventone, 214 Illinois, p. 314; Tygett *v.* Sunnyside Coal Co., 140 Illinois App., p. 79; Hammett *v.* Victoria American Fuel Co., 236 Federal, p. 527; Paletta *v.* Illinois Zinc Co., 257 Illinois, p. 14)

Company store. A store, selling groceries and general merchandise, owned and run by an industrial company (Webster). This type of store is common in mining and lumber camps.

Compartimiento (Sp.). Compartment of a shaft; *C. de aire*, a brattice (Haise). An air passage.

Compartment. A separate division or section of anything (Webster). Mining shafts usually are divided into two or more compartments or sections, separated by framed timbers and planking.

Compass. 1. An instrument for determining directions, usually by the pointing of a magnetic needle free to turn in a horizontal plane, as, for example, the ordinary surveyors compass though sometimes having a clinometer attached. Also, a dip-compass, for tracing magnetic iron ore, having a needle hung to move in a vertical plane. (Raymond)
2. An instrument for describing circles, transferring measurements, etc. (Webster)

Competent. In geology; 1. Combining sufficient firmness and flexibility to transmit pressure, and by flexure under thrust, to lift a superincumbent load: said of strata or of rock structure. 2. Able to transport débris of a given size: said of water streams. (Standard)

Complementary forms. In crystallography, two forms which, combined geometrically, produce a form with higher symmetry. (A. F. Rogers)

Complementary rocks. A term suggested by W. C. Brögger for the basic rocks, which, usually in the form of dikes, accompany larger intrusions of more acidic types, and "complement" them in a chemical sense. *Compare* Lamprophyre, Oxyphyre, and Radial dikes. (Kemp) The diverse differentiation products of one common magma. (Standard)

Complex. In mineralogy, containing many ingredients; compound or composite. Some geologists use the word as a noun to indicate a complex set of rocks folded together, or intricately mixed, involved, complicated, or enlarged. (Roy. Com.)

Complex fold. A fold which is cross folded, that is, one of which the axial line is folded. (Leith, p. 105)

Complex steel. An alloy steel containing more than two alloying elements, such as high-speed tool steel (Hibbard). It contains more elements than quaternary steel.

Componer con madera (Mex.). To timber a mine. (Dwight)

Composite. Made up of separate parts or elements; combined or compounded; not simple. (Standard)

Composite dike. A dike formed by two intrusions of different ages into the same fissure. (Kemp)

Composition. 1. An aggregate, mixture, mass, or body formed by combining two or more substances; a composite substance. (Webster)
2. The chemical constitution of a rock or mineral. (Power)

Composition face. In contact twin crystals, the face of actual contact. It may or may not be the twinning plane. (Standard)

Composition metal. A yellow alloy of copper, zinc, etc., used for sheathing vessels. (Standard)

Composition plane. The plane by which the two individuals of a contact twin crystal are united in their reverse positions (Dana). Also called Composition face.

Compound. 1. A distinct substance formed by the union of two or more ingredients in definite proportions by weight. (Webster)
2. A lubricant applied to the inside and outside of ropes, preventing corrosion and lessening abrasion of the rope when in contact with hard surfaces. (C. M. P.)
3. The walled or fenced inclosure of a European residence or factory in India, China, or the Malayan settlements; also, a similar inclosure containing a group of native houses (Standard). A term also used in Transvaal for the living quarters of the Kaffir miners.

Compound cradle. An apparatus composed of three tiers of blanket tables, a shaking table and a quicksilver riffle for catching gold. (Duryee)

Compound twins. In crystallography, individuals of one group united according to two or more different laws. (Standard)

Compound vein. 1. A vein or lode consisting of a number of parallel fissures united by cross fissures, usually diagonally. (Shamel, p. 139)
2. A vein composed of several minerals. (Power)

Compound ventilation (No. of Eng.). The system of dividing or splitting the air, and of ventilating the workings of a coal mine by giving to each district or panel a separate quantity of fresh air, and conveying the return air to a main air course direct from each panel. (Gresley)

Compresora de aire (sp.). An air compressor. (Lucas)

Compressed. Pressed together; compact; reduced in volume by pressure. (Webster)

Compression. 1. In steam practice, the action of the piston in compressing the steam remaining in the cylinder, after the closure of exhaust valves, into the clearance-space. (Ihlseng)
2. Also the point in the cycle of operations, at which compression occurs; the period during which compression occurs. (Webster)

Compression efficiency. The ratio of the work required to compress isothermally all the air delivered by an air compressor to the work actually done within the compressor cylinder, as shown by indicator cards, and may be expressed as the product of the volumetric efficiency (the intake pressure and the hyperbolic logarithm of the ratio of compression), all divided by the indicated mean effective pressure within the air cylinder or cylinders. (A. I. M. E., Bull. 140, p. lvii)

Compressor. *See* Air compressor.

Compromiso (Sp.). A private engagement or undertaking; also a joint-stock undertaking. (Min. Jour.)

Compuerta (Mex.). A sluice gate. (Dwight)

Común (Peru). Average ore. (Halse)

Concentrador; Concentradora (Sp.). A buddle; an ore concentrator. (Lucas)

Concentrados (Mex.). Concentrates. (Dwight)

Concentrar metal (Mex.) To concentrate ore. (Dwight)

Concentrate. 1. To increase the strength by diminishing the bulk as of a liquid or an ore; to intensify or purify by getting rid of useless material (Webster). To separate metal or ore from the gangue or associated rock. (Murray's Dict.)

2. That which has been reduced to a state of purity or concentration by the removal of foreign, nonessential, or diluting matter (Century). A product of a process of concentration, as in chemistry or metallurgy (Standard). The product of concentration (in mining). Used in plural form as "arrangements for treating the *concentrates* were complete" (Murray). Concentrates are called "ore" at Joplin, Mo.; "mineral" at Michigan copper mines, and "tailings" at Black Hawk, Colorado.

Concentrating plant. *See* Concentrator.

Concentration. 1. The removal by mechanical means of the lighter and less valuable portions of ore. (Raymond). *See* Ore dressing.
2. The act of increasing the strength of solutions by evaporating part of their water.

Concentration table. A table on which a stream of finely crushed ore and water flows downward and the heavier metallic minerals lag behind and flow off in a separate compartment. (Weed)

Concentrator. An apparatus in which, by the aid of water or air and specific gravity, mechanical concentration of ores is performed (Raymond). Also applied to the entire plant containing the various concentrating devices, or machinery. A concentration plant.

Concentric. That which has a common center with something else. (Webster)

Conchoidal. Shell-shaped. The more compact rocks such as flint, argillite, felsite, etc., break with concave and convex surfaces and are therefore said to have a conchoidal fracture. (Roy. Com.)

Concordant injection. An igneous mass injected along bedding planes. (Daly, p. 63)

Concreción (Mex.). Concretion. (Dwight)

Concrete. A mixture of sand, gravel, pebbles, or stone chippings, with cement or with tar, etc., used for sidewalks, roadways, floors, foundations, etc. (Webster)

Concretion. A spheroidal or discoidal aggregate formed by the segregation and precipitation of some soluble mineral like quartz or calcite around a nucleus, which is often a fossil. (Kemp)

Concretionary. Tending to grow together. Particles of like chemical composition, when free to move, come together and form nodules of various sizes and shapes which are called concretions. Clay and ironstone nodules, balls of iron pyrite, turtle-stones, etc., are good examples. Some greenstones exhibit concretionary structure. (Roy. Com.)

Concussion table. *See* Percussion table.

Condenser. A vessel or chamber in which volatile products of roasting or smelting (*e. g.*, mercury or zinc vapors) are reduced to solid form by cooling, or in which the fumes of furnaces, containing mechanically suspended as well as volatile metallic matters, are arrested. (Raymond). The function of the condenser is often performed by the introduction of cold water, or as in distillation, by placing the condenser in another vessel through which a current of cold water passes. Condensers of special form are largely used in those oil fields where salt water is employed for the generation of steam. (Mitzakis)

Condensing lens. A lens for producing convergent light. (Luquer, p. 9)

Conduct (Aust.). *See* Cundy, 2.

Conductor. 1. A substance capable of readily transmitting electricity, heat or the like. 2. A person who conducts or leads; a guide. (Webster)
3. *See* Guides, 1.
4. A wooden cylinder 12 to 13 ft. long used in America when sinking a new oil well. The conductor, which has a slightly greater diameter than that of the first string of casing, is inserted in the drill hole, and extends from the bottom of the first casing to the floor of the derrick. The object of the conductor is to guide the casing, great care being taken to secure its absolute vertically in the first place. (Mitzakis)

Conducta. 1. (Sp.) A convoy for the safe transportation of bullion or coin overland. (Hanks)
2. (Mex.) A bullion train. The bullion carried. (Dwight)

Conduction. Transmission through, or by means of a conductor. Distinguished, in the case of heat, from convection and radiation. (Webster)

Conductivity. Quality or power of conducting or of receiving and transmitting, as of heat, electricity. (Webster)

Conduit. 1. An artificial channel, as a canal, aqueduct or pipe for conveying water or fluid. 2. A tube or trough for receiving and protecting electric wires, as telephones, etc. (Webster)

Conduit hole. A flat or nearly horizontal hole drilled for blasting up a thin piece in the bottom of a level. (C. and M. M. P.)

Conduit pipe. Wrought-iron pipe used as armor for electric wires (Nat. Tube Co.). A tubular conduit.

Cone-in-cone. 1. A curious structure, occasionally found in clay rocks, whereby two opposing and interlocking sets of cones or pyramids are developed, with their axes parallel and their bases in approximately parallel surfaces. (Kemp)
2. Coal exhibiting a peculiar fibrous structure passing into a singular toothed arrangement of the particles is called Cone-in-cone coal, or crystallized coal. (Gresley)

Confining bed. A water-tight bed above or below a stratum containing artesian water. (Lowe)

Confluence. A junction or flowing together of streams; the place where streams meet. (Standard)

Confluent. 1. A stream that unites with another; a fork or branch of a river: especially applied to streams nearly equal in size, and distinguished from affluent. 2. Flowing together so as to form one stream. (Standard)

Conformability; Conformity. The mutual relation of conformable beds. (La Forge)

Conformable. When beds or strata lie upon one another in unbroken and parallel order, and this arrangement shows that no disturbance or denudation has taken place at the locality while their deposition was going on, they are said to be conformable. But if one set of beds rests upon the eroded or the upturned edges of another, showing a change of conditions or a break between the formations of the two sets of rocks, they are said to be unconformable. (Roy. Com.)

Congenial. A term applied to rocks in which lodes become ore bearing. (Duryee)

Conglomerado (Mex.). Conglomerate. (Dwight)

Conglomerate. An aggregate of rounded and water-worn pebbles and bowlders cemented together into a coherent rock (Kemp, p. 88). Deposited by streams or waves, generally with some sorting and stratification. *Compare* Breccia.

Congo. 1. (Colom.) Fragments of iron-ore, which accompany gold in placers; a coarse black sand. 2. Iron oxide in ore veins. (Halse)

Congruent forms. In crystallography two forms which may each be derived from the other by rotation about an axis of symmetry. (A. F. Rogers)

Coniagas. The name of a mine in the Cobalt district, Ontario. It is derived from the respective chemical symbols, Co, Ni, Ag, and As.

Conical drum. The drum of a winding engine, constructed in the form of two truncated cones placed base to base, the outer ends being usually the smaller in diameter. It may also be a single cone.

Conical refraction. The refraction of a ray of light at certain points of double-refracting crystals, so that on emerging from the crystal it widens from an apex into a hollow cone (*external conical refraction*), or on entering diverges into a cone and issues as a hollow cylinder (*internal conical refraction*). (Standard)

Conichalcite. A pistachio-green to emerald-green hydrous calcium-copper arsenate, perhaps $(Cu,Ca)_2AsO_4.(Cu,Ca)(OH)_2+\frac{1}{2}H_2O$, occurring reniform and massive, resembling malachite. (Dana)

Conkling magnetic separator. A conveying belt which passes under magnets, below which belts run at right angles to the line of travel of the main belt. The magnetic particles are lifted up against these cross belts and are thus removed. (Liddell)

Connarite. A hydrous nickel silicate perhaps, $H_4Ni_2Si_4O_{10}$; found in fragile grains having a yellowish or green color. (Dana)

Connate water. Water which was deposited simultaneously with the deposition of solid sediments, and which has not since its deposition existed as surface water or atmospheric moisture. (Meinzer)

Connecting. The operation of joining adjacent electric blasting cap wires to each other, to connecting and leading wires, in such a way that an electric current will flow through with the least possible resistance. (Du Pont)

Connecting rod (Eng.). A rod connecting a crank pin with a beam, crosshead, piston rod, or piston as in a steam engine. (Webster)

Connecting wire. A wire of smaller gauge than the leading wire used for connecting the electric blasting-cap wires from one bore hole to those of an adjoining one. (Du Pont)

Conoscope. A form of polariscope used for examining crystals in convergent polarized light. (Webster)

Consanguinity. The genetic relationship of those igneous rocks which are presumably derived from a common parent magma. (Kemp)

Consequent. 1. Pertaining to or characterizing the earth movements which result from the external transfer of material in the process of gradation; contrast with Antecedent. (Standard)
2. Having a course or direction dependent on, or controlled by, the geologic structure or by the form and slope of the surface: said chiefly of streams and drainage. (La Forge)

Consertal. An arrangement in which irregularly shaped crystals in juxtaposition are closely fitted together, or conserted. (Iddings, p. 223)

Conservation. A conserving, preserving, guarding, or protecting; a keeping in a safe or entire state; preservation, as of mineral resources.

Conservation of energy. One of the fundamental laws that whenever a change in mode of manifestation of energy takes place, the total amount of energy remains a constant. (Liddell)

Consey (Scot.). An underground branch road in stoop-and-room workings. (Gresley)

Consideration. 1. A recompense as for service; a fee or compensation. 2. An act or process of considering; continuous and careful thought; examination; deliberation. (Webster)
3. (Aust.). An extra payment given to men working under unfavorable conditions, *e. g.*, in a wet place. (Power)

Consistency. 1. The degree of solidity or fluidity of bituminous materials. (Bacon)
2. Condition of standing or adhering together; existence, firmness, solidity. (Webster)

Constantan. An alloy of equal parts of nickel and copper: used chiefly in electrical instruments on account of its constant resistance. (Standard)

Construction account. An account in mining finance to which all construction expenses are charged. Many of the Lake Superior copper mines summarize their finances so that the cost of operation is divided into two classes, one being for general working expenses and the other for construction, sometimes classed as capital account. It includes new buildings and machinery on surface and frequently new mine openings. (Weed)

Constructional. In geology, owing its form, position, direction, or general character to building-up processes, such as accumulation by deposition or by volcanic extrusion. (La Forge)

Construction way. A temporary way or road employed for the transportation of the materials used in the construction of a railroad. (Century)

Consume. To use up; expend; waste; as in the chemical and mechanical loss of mercury in amalgamation.

Consumido (Mex.). The mercury consumed and lost in an amalgamation process. (Dwight)

Contact. 1. The place or surface where two different kinds of rocks come together. Although used for sedimentary rocks, as the contact between a limestone and sandstone, it is yet more especially employed as between ingeous intrusions and their walls. The word is of wide use in western mining regions on account of the frequent occurrence of ore bodies along contacts. (Kemp)
2. (So. Afr.) A lode of great length and between two kinds of rocks, one of which is generally an igneous intrusive. (Skinner)

Contact bed. In geology, a bed lying next to (in contact with) a formation of different character. (Century)

Contact deposit. A mineral deposit found between two unlike rocks, usually applied to an ore body at the contact between a sedimentary rock and an igneous rock (Weed). A contact lode or vein.

Contact goniometer. A cardboard or metal protractor for the measuring of crystal angles.

Contact lode. *See* Contact, 2; Contact deposit; Contact vein.

Contact metamorphism. A general term applied to the changes which take place along a contact (of an intruded igneous rock and the enclosing rocks into which it has been thrust) such as recrystallization of limestone, or the formation of the typical silicate minerals (Farrell). Metamorphism produced by the heat of an igneous intrusion. Also called Thermometamorphism, or Local metamorphism.

Contact minerals. Minerals formed by contact metamorphism. (A. F. Rogers)

Contacto (Mex.). Contact. (Dwight)

Contact process. A process for the manufacture of sulphuric acid, based on the catalytic action of finely divided platinum. It is conducted by passing the well-dried and purified burner gases through the contact apparatus, at a temperature of 350° C. and absorbing the sulphur trioxide, formed by the direct union of sulphur dioxide and oxygen, in water. (Webster)

Contact twin. The simplest type of twin, in which two portions of a crystal appear to have been united along a common plane after one portion has been rotated 180° relative to the other. The plane of contact (plane of union or the composition face) may or may not be the twinning plane (Butler). *See also* Juxtaposition twin.

Contact vein. A variety of fissure vein, between different kinds of rock occupying a typical fracture from faulting, or it may be a replacement vein formed by mineralized solutions percolating along the surface of the contact where the rock is usually more permeable and there replacing one or both of the walls by metasomatic process (Shamel, p. 143). Also called Contact deposit.

Contador. 1. (Sp.) An accountant; auditor; clerk. 2. A mechanical counter or indicator; a meter for measuring water, gas, or electricity. (Halse)

Contaminate. To make impure by contact or admixture, as by a substance that performs the function, in an ore-pulp, along with oil, of promoting the emulsification or the deemulsification of the oil, and thereby exerts an influence upon the making of froth for the flotation of minerals. (Rickard)

Contemporaneous. Existing together or at the same time. (Webster)

Content. That which is contained; the thing or things held by a receptacle or included within specified limits (Webster). Often used in mining, as ore-content, mineral-content, copper-content, etc.

Contiguous. In actual contact; also near, though not in actual contact. (Webster)

Continental basin. A region in the interior of a continent comprising one or several closed basins. (Webster)

Continental deposits. Sedimentary deposits laid down within a general land area and deposited in lakes or streams or by the wind, as contrasted with marine deposits, laid down in the sea. (Ransome)

Continental glacier. A type of glacier covering an entire continent, or a large portion of it; an ice sheet, as the ice cap of Greenland. (Standard)

Continental plateau. A broad protuberance of the surface of the lithosphere, coinciding approximately with a continent, but including also a continental shelf. Contrasted with Ocean basin. (Webster)

Continental process. Same as the German process.

Continental shelf. A submarine plain of variable width forming a border to nearly every continent, as the submarine part of a continental plateau.

Continuous charge. A charge of explosive that occupies the entire drill hole except for the space at the top required for stemming. (Bowles)

Continuous coal cutter. A coal mining machine of the type that cuts the face of the coal without being withdrawn from the cut. (Steel)

Continuous kiln. 1. *See* Running kiln. Also called Draw kiln. 2. A kiln in which the waste heat from the hot brick chambers is used to heat the wares in other compartments still to be burned. (Ries)

Continuous process of distillation. A petroleum distillation process in which the crude oil flows slowly by gravitation through a series of stills or retorts each placed slightly lower than the preceding one. Each still has a carefully maintained temperature, and yields, therefore, continuously a product of given volatility. (Mitzakis)

Contorted. Bent or twisted together. Used where strata are very much folded or crumpled on a considerable scale. If on a small scale they are said to be corrugated. (Roy. Com.)

Contortion. The folding, and bending to which rock strata have been subjected. (Oldham)

Contour. 1. The outline of a figure or body; periphery. 2. The outline of the surface of the ground with respect to its undulation (Webster). 3. An imaginary line on the surface of the ground, every point of which is at the same altitude. (La Forge)

Contour interval. The difference in elevation between consecutive contour lines. (Webster)

Contour line. *See* Contour, 3.

Contour map. A map showing the configuration of the surface by means of contour lines drawn at regular intervals of elevation as one for every twenty feet, a crowding of the contour lines indicating steepness. (Webster)

Contour race. A water-course following the contour of the country. (Lock)

Contra (Sp.). The person who carries away the material dumped at the mouth of a shaft; *C. cañon*, drift in country rock, parallel with drift on vein; *C. cielo*, top of a drift; a raise; *C. mina*, countermine; a communication between mines, or a tunnel communicating with a shaft; *C. pozo*, a raise; *C. sena*, bell-signal. (Dwight). *C. tiro*, an auxiliary shaft contiguous to a main shaft, to serve as a footway, or for ventilation. (Min. Jour.)

Contraction. Shrinking. Rocks in passing from a vitreous to a crystalline texture shrink considerably, which may account for the subsidence of certain areas. The whole globe of the earth has shrunk by cooling. (Roy. Com.)

Contraction vein. A vein formed by the filling of a space caused by contraction due to the drying or cooling of the surrounding rock. (Power)

Contrafuerte (Sp. Am.) Part of a lode left intact. (Lucas)

Contraguia (Mex.). A movable guide pulley over shaft. (Dwight)

Contra-lode. *See* Cross course.

Contranatural (Mex.). A vein having a contrary dip to other veins of the same system. (Halse)

Contrata (Sp.). A deed, contract, or agreement. (Halse)

Contratanque (Mex.). A second settling tank. (Halse)

Contratiro (Mex.). An auxiliary shaft to serve as a footway, or for ventilation. (Halse)

Contratista (Mex.). A contractor. (Dwight)

Contrato (Mex.). A pact or agreement between parties to perform some act; a contract. (Dwight)

Control assay. An assay made by an umpire to determine the basis on which a purchaser shall pay the seller for ore. *See also* Umpire, 2.

Convection. A process of transmission, as of heat, by means of currents in liquids or gases, resulting from changes of temperature or other causes. (Webster)

Convenio (Sp.). A legal agreement. (Min. Jour.)

Convergent light. Light tending to one point or focus. (Webster)

Converse lock joint. A joint, for wrought pipe, that is made up with a cast-iron hub. (Nat. Tube Co.)

Converter. 1. An electric transformer (Standard). 2. A vessel in which metals or other materials are changed or converted from one shape or condition to another. Specifically an oval-shaped vessel or retort, hung on an axis, made of iron and lined with some refractory material, in which molten pig-iron is converted by the Bessemer process into steel (Century). Also used in converting copper matte.

Converting. *See* Bessemer process. The process was applied to the metallurgy of copper by Pierre Manhés. Air is blown through molten copper matte in the presence of free silica. The iron is oxidized to FeO which forms a slag with the silica; the sulphur is oxidized and goes off as SO_2. (Liddell)

Converting coal (Mid.). A local name given to coal suitable for steel-making purposes at Sheffield. (Gresley)

Conveyer; Conveyor. 1. One who or that which conveys, transports, or transfers; specifically, any mechanical contrivance for conveying material in the working of mills, elevators, etc., such as endless chains, etc. (Standard)

Convoy (Eng.). A wooden brake formerly aplied to one of the wheels of a coal wagon. (G. C. Greenwell)

Convulsion. A sudden and violent disturbance of the order of the rocks; a terrestrial catastrophe; cataclysm. (Standard)

Cooler arch. An opening of truncated-cone shape in tuyère breast of furnace. The tuyère cooler is placed in it. (Willcox)

Cooling. Applied to minerals having the taste of saltpeter. (Dana)

Cooling floor. A floor upon which hot ore is placed for the purpose of cooling. (Rickard)

Cooling tower. A device for cooling the water used in a steam condenser or refrigerating plant. (Century)

Coom (Scot.). 1. Wooden centering for an arch; hence the roof of a mine or roadway is said to be coomed when it is arch-shaped. 2. Soot; the dust of coal. (Barrowman)

Coor (Eng.). A period of six or eight hours' work by miners, making four or three periods to the day of twenty-four hours. *See* Core, 1. (Bainbridge). A Shift.

Coorongite. A South Australian elaterite, or mineral caoutchouc. (Bacon)

Coose. *See* Coarse lode.

Copador (Mex.). Blacksmith's fuller. (Dwight)

Copajira (Bol.). Acid water in mines. (Halse)

Copal. An oxygenated hydrocarbon; a fossil resin. (Dana)

Copalillo (Mex.). Zincblende. (Dwight)

Copaline. Same as Copalite.

Copalite. An oxygenated hydrocarbon resembling copal, from the blue clay of Highgate, near London, England. (Dana)

Cope. 1. (Derb.) To contract to mine lead ore by the dish, load, or other measure. 2. The upper part of a flask, separable from the lower part. *See also* Drag, 3. (Raymond)
3. An exchange of working places between miners, sometimes spelled Coup. (C. and M. M. P.)
4. (Derb.). A duty or royalty paid to the lord or owner of a mine. (Hooson)

Copela. (Sp.) 1. A cupel. 2. The test of a cupelling furnace. (Halse)

Copelar (Sp.). To assay by cupellation. (Halse)

Copelilla (Mex.). Lead carbonate. (Dwight)

Copella (Sp.). Dry amalgam remaining in the bag after draining. (Egleston)

Coper (Derb.). One who contracts to mine lead ore at a fixed rate (Raymond). A Derbyshire miner.

Copi. Gypsum, generally weathered. (Power)

Copiapite. A basic ferric sulphate, perhaps $2Fe_2O_3.5SO_3.18H_2O$ (Dana). Also called Yellow copperas, and Misy.

Coping. 1. The top or cover of a wall usually made sloping to shed water. (Century)
2. In marble works the process of trimming the edges of slabs of stone (Bowles). *See also* Coping machine.

Coping machine. A machine, consisting of a gearing and a carborundum wheel for cutting and trimming marble slabs, as for base boards, tile, etc. (Bowles)

Copos (or Pasillas) (Sp.). In amalgamation, little globules into which the quicksilver forms, when the process is too quick. (Min. Jour.)

Coppel. Same as cupel. (Standard)

Copper. A common metal of reddish color, ductile, malleable, and very tenacious. One of the best conductors of heat and electricity. Symbol, Cu; atomic weight 63.57. Specific gravity, 8.93. (Webster)

Copperas. Ferrous sulphate. Also called Green vitriol.

Copperasine. A sulphate of iron and copper resulting from the decomposition of chalcopyrite. (Standard)

Copperas stone. A synonym for Pyrite, from which copperas is often made. (Chester)

Copper barrilla (Bol.). Native copper in granular form mixed with sand. *See* Coro-Coro, *also* Barrilla.

Copper bath. A solution of copper salt, as the sulphate used in electroplating. (Standard)

Copper bottoms. A metallic product of very indefinite composition, made (usually) in reverberatory furnaces by smelting rich cupriferous substances without sufficient sulphur to quite satisfy the copper present. (Peters, p. 227)

Copper glance. *See* Chalcocite.

Copperization. Impregnation with copper, or some preparation containing copper. (Century)

Copper loss. Electric energy wasted in the copper conductors of a dynamo, motor or conducting system. (Webster)

Copper minerals. Minerals containing copper, as atacamite, azurite, bornite, bournonite, brochantite, chalcanthite, chalcocite, chalcopyrite, chrysocolla, copper, covellite, cuprite, enargite, malachite, melaconite, olivenite, stannite, tetrahedrite, and others.

Copper nickel. *See* Niccolite.

Copper pickers (Mich.). Laborers who sort vein material in which there is more or less native copper. (Sanders, p. 89)

Copper plates (Aust. and Pac.). The plates of amalgamated copper over which the auriferous ore is allowed to flow from the stamp battery, and upon which the gold is caught as amalgam. (Raymond)

Copper powder. A bronzing powder made by saturating nitrous acid with copper, and precipitating the latter by the addition of iron. The precipitate is then thoroughly washed. (Century)

Copper pyrite. Same as Chalcopyrite. (Standard)

Copper rain. Minute globules thrown up from the surface of molten copper, when it contains but little suboxide. (Raymond)

Copper slate. Slate impregnated with copper minerals. (Duryee)

Copper smoke. The gases from the calcination of sulphide copper ore (Raymond). Sulphur dioxide is an important constituent.

Copper sulphate. *See* Chalcanthite.

Copper uranite. *See* Uranite; Torbernite.

Copper vitriol. *See* Chalcanthite.

Coprolite. A piece of petrified dung; a fossil excrement. Such remains are found in many geological formations. (Webster)

Copt (Aust.). A capsized or broken skip. (Power)

Coquimbite. A granular, massive, hydrous ferric sulphate, $Fe_2(SO_4)_3+9HO$. (Dana)

Coquina (Sp.). A coarse-grained, porous, friable variety of limestone, made up chiefly of fragments of shells of living or recently extinct species of mollusks and of coral, cemented together as rock. (La Forge)

Coracite. An alteration product of uraninite partly changed to gummite. (Standard)

Corahuari (Peru). A green copper ore. (Halse)

Coral. The solid secretion of coral polyps, composed almost wholly of calcium carbonate, which forms reefs and treelike and globular masses. (La Forge)

Coral limestone. A limestone composed of coral fragments. Such a rock is much used in the Bermuda Islands. (Ries)

Coralline. Pertaining to, composed of, or having the structure of corals; as coralline limestone.

Coralloidal. Like coral, or consisting of interlaced flexuous branchings. (Dana)

Coral mud. The sediment or mud formed by the disintegration of coral. (Century)

Coral ore. A curved, lamellar variety of liver-colored cinnabar from Idria, Austria. (Standard)

Coral rag (Eng.). The upper member of the Middle Oölite, so called because it consists, in part, of continuous beds of corals, for the most part retaining the position in which they grew, and sometimes forming masses 15 feet thick. (Page)

Coral zone. The depth of the sea at which corals abound. (Century)

Corbond. An irregular mass or "dropper" from a lode. (Raymond)

Cord. A cubic measure used especially for wood cut for fuel. It is, now legally in the United States, a pile 8 ft. long, 4 ft. wide and 4 ft. high, or 128 cu. ft. (Webster)

Cordeau. A trade name for a type of detonating fuse consisting of trinitrotoluene inclosed in a lead tube. (Bowles)

Corder (Eng.). The man who makes and repairs corves (small cars). (Bainbridge)

Cordierite. A magnesium-iron-aluminum silicate. Sometimes used as a gem. (U. S. Geol. Surv.) A synonym of iolite or dichroite, employed as a prefix to those rocks that contain the mineral, as cordierite-gneiss. (Kemp)

Cordillera. Strictly, a continuous chain or range of mountains. Generally, a whole mountain province, including all the subordinate mountain ranges and groups and the interior plateaus and basins. Specifically, (capitalized), the great mountainous region of western North America, lying between the Central Lowland and the Pacific Ocean, and extending from central Mexico into Alaska; also called Cordilleran Province. (La Forge)

Cordirie process. The refining of lead by conducting steam through it, while molten, to oxidize certain metallic impurities. (Raymond)

Cordite. An explosive of nitroglycerin and a dope, used chiefly as a propellant. (Standard)

Cord of ore. About seven tons, but measured by wagon loads, and not by weight. The expression "cord" is a term used in some parts of Colorado, U. S., and applied only to low-grade ore; the smelting ore is reckoned by the ton. (Milford)

Cordón (Mex.). A rib or band of ore in a vein (Halse). Feeder.

Core. 1. (Corn.) A miner's underground working-time or shift (Raymond). Also spelled Coor.
2. A cylinder-shaped piece of rock produced by a core-drill. (Steel)
3. The central part of a rope forming a cushion for the strands. In wire ropes it is sometimes made of wire, but usually it is of hemp, jute, or some like material. (C. M. P.)
4. The portion of a mold which shapes the interior of a hollow casting, or which makes a hole through a casting. (Webster)
5. A cone or V-shaped mass of rock that is first blasted out in driving a tunnel. (Bowles)

Core bit. A hollow cylindrical boring bit for cutting out a core in earth boring or rock drilling (Webster). In operation it is attached to and forms part of the core drill.

Core box. The box in which the core, or mass of sand producing any hollow part of a casting is made. (Century)

Core drill. A diamond or other hollow drill for securing cores (C. M. P.); (Bowles v. Virginia Soapstone Co., 115 Virginia, p. 699). *See also* Diamond drill; Adamantine drill; Shot drill, and Calyx.

Core iron. A strengthening iron grate in a core. *See* Core, 4 (Webster). A term used in foundry practice.

Core lifter. An instrument used to bring up the core left by an annular bit in a boring. (Standard)

Core sand. A sand suitable for making cores: composed of sand, clay and horse-dung. (Standard)

Core snatcher. A company man who collects and takes care of drill cores when the drilling is being done by contract.

Corf bater; Corf bitter (No. of Eng.). A boy who cleans the dirt or mud off corves. *See* Corf, 1. (Gresley)

Corf; Corfe; Corve; Cauf (the last incorrect). 1. (Newc.) A large basket used in hoisting coal; from the Germ. *Korb*. 2. A wooden frame to carry coal. 3. A sled or low wagon for the same purpose. (Raymond)
When used for bringing up the rock from a sinking shaft the corves are made without wheels, and are more like a basket. In early days corves were wicker baskets, having wooden bows or handles: they held about 4¼ cwt. of coal (Gresley). *See* Hutch, 1.

Corf bow (Eng.). The handle of a corf. (Bainbridge)

Coribronce (Mex. and Bol.). Chalcopyrite. (Dwight)

Corindón; Corundo (Mex.). Corundum. (Dwight)

Corinthian process. *See* Carinthian process.

Cork fossil. A variety of amphibole or hornblende, resembling cork. It is the lightest of all minerals. (Century)

Cormano (Mex.) A loading chute. (Dwight)

Cornamusa (Peru). An earthen retort with a movable cover. (Dwight)

Cornbrash (Eng.). A local name for certain beds in the Oölite formation. It signifies a coarse fragmentary rock which breaks up easily, and yields a soil useful for growing corn (Oldham). Also called Cornstone.

Córnea (Peru). Horn silver. (Dwight)

Cornean (Eng.). An igneous rock, so called from its tough, compact, and horn-like texture; known also as Aphanite. (Page)

Corner break. The separation of a block of stone from a solid ledge by breaking it simultaneously along two faces meeting at a corner. (Bowles)

Corner rackings (Scot.). Triangular pieces of wood inserted in the corners of rectangular shafts to fix the barring. (Barrowman)

Corners (Wales). Bands of clay ironstone. (Gresley)

Cornet; Cornett (Fr.). In assaying, a metallic bead flattened out and made into a roll for treatment with acid. (Webster)

Corning (Scot.). Mealtime. (Barrowman)

Corning table. *See* Bilharz table.

Cornish diamond. A quartz crystal from Cornwall. (Webster)

Cornish engine. A single-cylinder, single-acting beam engine using steam expansively and regulated by an hydraulic control (Webster). *See* Cornish pump.

Cornish mining ton. A ton of 21 hundred weight of 112 pounds each, or 2,352 avoirdupois pounds. (Webster)

Cornish pump. A pump operated by rods attached to the beam of a single-acting, condensing beam-engine. The steam, pressing down the piston in the vertical steam cylinder, lifts the pump rods, and these subsequently descend by their own weight. (Raymond)

Cornish stone. China-stone or kaolin (Standard)

Cornstone. A reddish or bluish-red concretionary limestone. Its decomposition is said to produce a good soil for the cultivation of corn, being so different from the cold. stiff, clayey soils formed over the marls (Oldham). Also called Cornbrash.

Cornubianite. A name coined by Boase from the classic name for Cornwall, England, to describe a contact hornfels, consisting of andalusite, mica and quartz. It was proposed as a substitute for the earlier but indefinite term proteolite. Bonney suggests restricting cornubianite to tourmaline hornfels. (Kemp)

Cornwallite. An emerald-green, massive, hydrous copper arsenate, $Cu_3As_2O_8.2Cu(OH)_2+H_2O$. (Dana)

Coro-coro. A dressed product of copper-works in South America, consisting of grains of native copper mixed with pyrite, chalcopyrite, mispickel, and earthy minerals (Raymond). *See* Copper barrilla; *also* Barrilla.

Corona. 1. (Sp.) The boring bit or crown of a diamond drill. 2. *C. cortante*, a cutting ring used in shaft sinking through watery strata. 3. The crown wheel of a Chilean mill. 4. (Colom.). A wooden bevel wheel used in a native mill. (Halse)

Coronadite. A manganate of lead and manganese. $(Mn,Pb)Mn_8O_{17}$. Resembles psilomelane in general aspect. (U. S. Geol. Surv.)

Corpa (Peru). 1. An ore containing galena, gray copper and native silver. 2. Sulphate of iron. (Dwight)

Corporal (Mid.). A district foreman in charge of the underground haulage ways. (Gresley)

Corpuscle. *See* Electron.

Corral. 1. (Mex.) A stableyard or an inclosure. (Dwight)
2. A complete set of props; crib-timbering. (Halse)

Corrasion. The wearing away of the surface of the earth through the friction of solid material transported by water or air. It is one form of erosion. (La Forge)

Correa. 1. (Mex.) A leather strap. (Dwight)
2. *Metal de correa*, nearly pure cassiterite. 3. Horizontal timbers which tie the rafters of a roof together. (Halse)

Corredero (Colom.). The bed of an ancient river; a former channel of a stream. (Halse)

Corrego (Port.). 1. A ravine. 2. An alluvial channel. 3. (Braz.) A stream where auriferous gravel is washed. (Halse)

Correlate. To put in relation with each other; to connect as by the disclosure of a mutual relation. (Webster)

Correlation. The determination of the equivalence in geologic age and stratigraphic position of two formations or other stratigraphic units in separated areas; or, more broadly, the determination of the contemporaneity of events in the geologic historys of two areas (La Forge). Fossils constitute the chief evidence in problems of correlation.

Correo (Sp.). 1. A post man. 2. Post office. 3. Mail. (Halse)

Corrida. 1. (Sp.) The strike of a vein. (Dwight)
2. *Metal C.*, alluvial ore; *Oro C.*, alluvial gold. (Halse)

Corriente. 1. (Peru) All the operations required for extracting metal on a large scale from one class of ore. (Dwight)
2. (Sp.) Current, as of a stream; *C. de aire*, an air current. (Halse)

Corrode. To eat away by degrees as by acids, caustics or other chemicals. To act corrosively; to undergo corrosion. (Webster)

Corroded crystals. Phenocrysts that after crystalization are more or less reabsorbed or fused again into the magma. (Kemp)

Corroding-lead. Refined lead sufficiently pure for the corroding process, by which white lead is manufactured. (Raymond)

Corrois (Fr.). Clay walls built to isolate a gob-fire. (Gresley)

Corrosion. The process of wearing away, disintegrating or destroying by the gradual separation of small parts or particles, especially by the action of chemical agents, as an acid (Century). *Compare* Corrasion.

Corrosive. Anything that corrodes especially a chemical agent, as an acid; anything that wears away or disintegrates. (Century)

Corrosive sublimate. Mercuric chloride, $HgCl_2$. Called also Bichloride of mercury. It is a virulent poison. (Webster)

Corrugated. When beds on a small scale are much wrinkled, folded or crumpled, they are said to be corrugated. On a larger scale they are said to be contorted. (Roy. Com.)

Corsite. A name applied by Zirkel to the orbicular or spheroidal diorite from Corsica; synonym for Napoleonite. (Kemp)

Cortada. 1. (Colom.) A straight cut made to connect two bends of a river in order to work the bed of the river as a placer at the intermediate bend. 2. (Chile) A cut or drift on a vein. 3. Any working driven to cut a vein; a crosscut. (Halse)

Cortador de leña (Sp.). A wood chopper (Halse). A synonym for Leñador.

Cortadores (Sp.). Wood cutters. (Min. Jour.)

Cortafrio (Mex.). Cold chisel. (Dwight)

Cortar (Sp.). 1. To cut. 2. *C. alturas*, to cut a trench at the outcrop of a deposit, and then deepen it by underhand stoping. 3. *C. pilar* (Mex.) To form a rock support or pillar in a mine. (Halse)
4. *C. sogas* (Mex.) Literally, to cut the ropes. To abandon a mine, taking everything useful or movable. (Dwight)
5. *C. el oro*, to separate gold from the foreign matter. (Lucas)

Corte (Sp.). 1. Edge of any cutting instrument. 2. Cut or opening in a mountain. 3. (Colom.) The working portion of a placer, or vein at the surface; a stope. (Halse)
4. (Peru) Opening to an ore-deposit, either a shaft or drift. 5. (Peru) Pay-streak left clear so that ore can be knocked down without becoming mixed with waste. 6. *C. de caja* (Mex.) Balance sheet of accounts. (Dwight)

Corteza (Mex.). Crust. (Dwight)

Cortlandtite. A special name given by G. H. Williams to a peridotite that consists chiefly of hornblende and olivine and that occurs in the so-called Cortlandt series of igneous rocks in the township of Cortlandt, just south of Peekskill, on the Hudson River. This rock had been previously called hudsonite by E. Cohen, a name rejected by Williams because already used for a variety of pyroxene. (Kemp)

Corundolite. Wadsworth's name for rocks composed of corundum or emery. (Kemp)

Corundum. 1. Aluminum oxide, Al_2O_3. The colored and the clear varieties form the gems,—sapphire, ruby, oriental emerald, and oriental topaz; the granular impure variety is known as emery. (U. S. Geol. Surv.) 2. The name of the mineral is sometimes prefixed to the names of rocks containing it; as corundum-syenite. (Kemp)

Corve. See Corf.

Corvers (No. of Eng.). Carpenters who make corves (baskets). Also formerly one who brought corves out of the mine, and kept them in repair. (Gresley)

Cosalite. A sulphide of lead and bismuth, $Pb_2Bi_2S_5$. Contains 42 per cent bismuth. (U. S. Geol. Surv.)

Cosecha (Chile). A clean-up at placer mines. (Halse)

Cosmic. Of or pertaining to the celestial universe, especially to that part of it outside the solar system. (La Forge)

Cosmites. A term used by M. E. Wadsworth to designate mineral decorative materials, ornamental stones, and gems. (Power)

Costado (Sp.). The side of a pit, gallery, or shaft. (Halse)

Costal (Mex.). An ore sack or bag made of the thread of the aloe. (Halse)

Costalera (Mex.). Ore-sacks (collectively). (Dwight)

Cost book (Corn.). A book used to keep accounts of mining enterprises carried on under the cost-book system, peculiar to Cornwall and Devon, and differing from both partnership and incorporation. It resembles the mining partnership system of the Pacific States. (Raymond)

Cost-book system (Eng.). The method of working a mine according to certain regulations, by which the adventurers may at any time "sign off", and cease to be liable for any further expenditures in proving the mine. The plan is to insert in the "cost book" the name of each shareholder, and all expenses attached to the undertaking; a meeting of the proprietors is held every two months, at which the purser presents his accounts, and the shareholders are thus enabled to judge of the state of the undertaking before incurring any further liabilities. (Whitney)

Costeable (Mex.). Sufficiently rich to pay expenses at least (said of ore ground, stopes, etc.). (Dwight)

Costean (Corn.). 1. To dig trenches or small pits through the surface soil or débris to the underlying rock in places for the purpose of exposing the outcrop of a mineral deposit and determining its course. (Webster)
2. Fallen or dropped tin. From the Cornish, *Cothas*, dropped, and *Stean*, tin. (Hunt)

Costean-pit (Corn.). A pit sunk to bedrock in prospecting. (Standard)

Costearse (Mex.) To pay for itself. (Dwight)

Costo; Costa; Coste (Sp.). 1. Cost or price. *C. neto*, net cost. 2. Expense, working cost. *C. del beneficio*, cost of reduction. (Halse)
3. *C. de los journales*, the labor working cost. (Dwight)

Costra (Chile). 1. A conglomerate of clay, gravel, and feldspar immediately overlying *caliche*. 2. Scale, or portion of a lode or rock which breaks off in scales or flakes. (Halse)

Coteau (Fr.) A hill or ridge, which may be morainic; also, a high plateau. (Standard)

Cotense (Mex.). Miner's sash cloth, or breechclout. Coarse hempen cloth similar to burlap. (Dwight)

Coto (Sp.). 1. In surveying, a landmark of rough stone. 2. *C. minero*, a group of mines. (Halse)

Cotter (Eng.). To mat together; to entangle. Frequently applied to a hard, cross-grained, tough stone or coal, as cottered coal. (G. C. Greenwell)

Cotterite. A variety of quartz having a peculiar metallic pearly luster. (Standard)

Cotton ball. *See* Ulexite.

Cotton miner (Quebec). A miner employed in an asbestos mine.

Cotton rock. 1. (Missouri). A local name for a soft, fine-grained siliceous magnesian limestone of the Lower Silurian. (Century)

Cotton stone. 1. A variety of mesolite (Power). 2. *See* Cotton rock.

Cotunnite. A soft white to yellowish lead chloride, $PbCl_2$. Occurs in acicular crystals of the orthorhombic system and in semicrystalline masses. (Dana)

Cougas (Mex.). A black mineral wax or oil. (Halse)

Coulch (Derb.). A piece of earth falling from the roof or side in soft workings. (Hooson)

Coulee. 1. A solidified stream or sheet of lava extending down a volcano, often forming a ridge or spur. 2. A deep gulch or water channel; usually dry. (C. and M. M. P.)

Coulomb. The practical unit of quantity in electrical measurements; namely, the quantity of electricity conveyed in one second by the current produced by an electro-motive force of one volt acting in a circuit having a resistance of one ohm. (Webster)

Counter. 1. A cross-vein. 2. (Or counter-gangway.) A gangway driven obliquely upwards on a coal seam from the main gangway until it cuts off the faces of the workings, and then continues parallel with the main gangway. The oblique portion is called Run. (Raymond)
3. An apparatus for recording the number of strokes made by a pump, engine, or other machinery.

Counterbalance; Counterpoise. A weight used to balance another weight or the vibrating parts of machinery. (Ihlseng)

Counter chute. A chute through which the coal from counter-gangway workings is lowered to the gangway below. (Chance)

Counter coal. Coal worked from breasts or bords to the rise of a counter gangway. (Gresley)

Counter gangway. A gangway driven obliquely across the workings to a higher level, or a gangway driven between two lifts and sending its coal down to the gangway below through a chute. (Chance)

Counterhead (Mid.). An underground heading driven parallel to another, and used as the return air course. (Gresley)

Counterlode. A smaller vein running across the main lode. (Skinner)

Counterpoise. *See* Counter-balance.

Countervein. A cross vein running at approximately right angles to the main ore body (Weed). *See also* Counterlode.

Country (Corn.). The rock traversed by or adjacent to an ore deposit. *See also* Country rock. (Raymond)

Country bank (Ark.). A small mine supplying coal for local use only. (Steel)

Country rock. The general mass of adjacent rock as distinguished from that of a dike, vein or lode. (Stevens *v.* Williams, 23 Federal Cas., p. 44)

Country sale (Scot.). Sale of coal at the mine; sale by cart, as distinguished from disposal by rail or sea. (Barrowman)

County of Durham system. A combination of the panel and room-and-pillar method of mining. *See also* Room-and-pillar method.

Coup. 1. (No. of Eng.). To exchange cavils (lots) with the consent of the foreman. (Gresley)
2. (Scot.) A bank, or face of a heap where débris is dumped. 3. To overturn. (Barrowman)

Couple. 1. A pair of equal forces, acting in opposite directions but not on the same point. They can not be balanced by any single force, and their tendency is to produce motion. (Webster)
2. (Mid.). To conduct water down the sides of shafts into water curbs or garlands. (Gresley)

Coupler (Eng.). A boy who couples or connects the cars of coal, ore or rock in order to form a trip or train.

Coupling. 1. A threaded sleeve used to connect two pipes (Nat. Tube Co.)
2. A device for joining two rope ends without splicing. (C. M. P.)
3. (York) An attachment for joining a chain to the end of a rope. (Gresley)
4. A link or chain for connecting mine cars.

Coupling chains (Scot.). Short chains conecting the cage with the winding rope (Barrowman). *See* Bridle chains.

Coupling tongs (Scot.). A tool used in joining flanged pipes. (Barrowman)

Coup-over (Aust.). **Coup-up** (Scot.). A small chamber, into which an empty skip can be upset so as to allow a full skip to pass when there is only a single line. (Power)

Course. 1. To conduct the ventilation backward and forward through the workings, by means of properly arranged stoppings and regulators.

2. (Som.) A seam of coal. (Gresley)
3. The horizontal direction or strike of a lode, vein, etc. 4. Progress from point to point without change of direction. 5. A continuous layer of brick masonry, cement or concrete. (Webster)
6. An influx of water from one direction. (Standard)

Coursed rubble. Rubble in courses of differing breadths. (Standard)

Course of ore. *See* Chute, 2; *also* Course, 3.

Course of vein. Its strike. The horizontal line on which it cuts the country rock. (Duryee)

Coursing. Ventilation in mines, as by doors, brattices and stoppings. (Standard)

Coursing the air. *See* Course, 1.

Coursing the waste. *See* Course, 1.

Courtzilite. A form of asphaltum allied to gilsonite. (Bacon)

Cousie (pronounced **Cowssie**) (Scot.). A self-acting plane. (Barrowman)

Cousie wheel (Scot.). The drum or pulley on a self-acting plane. (Barrowman)

Cousin Jack. A common nickname for a Cornishman. (Raymond)

Covacha (Mex.). A cave or crevice. (Dwight)

Covellite. An indigo-blue copper sulphide, CuS. Contains 66.4 per cent copper. (U. S. Geol. Surv.)

Cover. 1. (No. of Eng.) The total thickness of strata overlying the mine workings (Gresley). Overburden.

Cover binding (Corn.). *See also* Plank timbering.

Covering bords (York). A series of bords (rooms) formed on the side of a shaft pillar, from which longwall working is commenced. (Gresley)

Cover work. Lumps of copper too large to pass the screen and which accumulate in the bottom of the mortar of a stamp. (Richards, p. 121)

Covite. A name derived from Magnet Cove, Ark., and suggested by H. S. Washington for a leucocratic, holocrystalline combination of orthoclase (alkali-feldspar) and less nephelite, with hornblende and aegirite-augite, and of granitic structure. The rock was previously described as a "fine-grained syenite," by J. F. Williams. (Kemp)

Cow. A kind of self-acting brake for inclined planes; a trailer. (Raymond). *Compare* Cousie.

Cowl (No. of Eng.). A wrought-iron water barrel, or tank for hoisting water. (Gresley)

Cowp (Newc.). 1. To overturn. To exchange working places. *See also* Coup. (Min. Jour.)

Cowper-Siemens stove. A hot-blast stove of firebrick on the regenerative principle. (Raymond)

Cow stone (Eng.). A local term for green-sand bowlders. (Roberts)

Cow sucker. A heavy piece of iron attached to the end of the drilling cable in order to facilitate the descent of the latter when the tools are disconnected. (Mitzakis)

Coyote (Mex.). A man who buys and sells mining shares. (Dwight)

Coyote hole. Same as gopher hole. A small tunnel driven horizontally into the rock at right angles to the face of the quarry. It has two or more cross-cuts driven from it parallel to the face. It is in the ends of these cross-cuts that the explosive charge is generally placed, and the remaining space in the tunnel is filled up with rock, sand, timbers, or concrete, to act as stemming or tamping. (Du Pont)

Coyoting (Pac.). Mining in irregular openings or burrows, comparable to the holes of coyotes or prairie foxes (Raymond). Gophering.

Coz. 1. (Mex.). A hitch for a stull. (Dwight)
2. (Colom.) The pointed end of a leg piece or post. (Halse)

Crab. 1. A machine for moving heavy weights. Especially the engines employed for lowering into place the pumps, rods, pipes, etc., of Cornish pit-work. *See also* Crabwinch. (Raymond)
2. An iron rod forked at one end, attached to loaded coal cars coming up out of a slope. (Roy)
3. A hoisting winch used to pull ladles, cars, or iron plate in boiler shop; also called Mule or Car dumper. (Willcox)

Crab hole (Aust.). 1. Holes, apparently water-worn, found in the bedrock under the drift. (Davies) 2. The hole burrowed by the Australian land crab, or crawfish; also the hollow form by caving in of one of these burrows. (Webster)

Crab winch. An iron machine consisting of two triangular uprights between which are two axles, one above the other. These machines are frequently used in connection with pumping gear where mine shafts are not deep. *See also* Crab, 1. (Duryee)

Cracker. A coal breaker. (Daddow)

Cracker boss. The officer in charge of the screen room in a breaker. (Greene)

Cracket (No. of Eng.). A tool used by miners in mining coal. (Gresley)

Cracking of oil. A name given to the method by which hydrocarbons of one composition are reduced to lower members of the same series, or converted into other hydrocarbons during distillation (Mitzakis). It originated about 50 years ago by the stillmen in the old Pennsylvania refineries and means just what its connotation conveys, namely a part alteration, as distinguished from the more complete decomposition which would disrupt the molecule largely into carbon and permanent gas. Cracking simply alters the molecules to an extent that produces an amount of low-boiling fractions that can not be obtained by simple distillation. It may not be accomplished by any considerable production of permanent gas, the product being largely a liquid condensate, but of different character from that obtained by simple distillation. (Min. and Sci. Press, May 1, 1915)

Crackle ware. Pottery or porcelain covered with a delicate network of cracks produced in the glaze. (Standard)

Cracks (Scot.). Vertical planes of cleavage in coal. Planes at right angles to the bedding. (Gresley)

Cracks of gas. Puffs or explosions of gas in blast furnaces. (Willcox)

Cradle. 1. (Eng.) A movable platform or scaffold suspended by a rope from the surface, upon which repairs or other work is performed in a shaft. 2. (Mid.). A loop made of a chain in which a man is lowered and raised in a shaft not fitted with a cage. (Gresley) 3. A wooden box, longer than wide, provided with a movable slide and hopper, and mounted on two rockers. It is used for washing gold-bearing earths (Roy. Com.). *See also* Rocker. 4. To wash gold-bearing material in a cradle. (Webster) 5. The part of a car dumper in which the car rests when it is dumped. (Willcox)

Cradle dump. A tipple which dumps cars with a rocking motion. (Harr)

Cradling (Scot.). Stone walling in a mine shaft. (Barrowman)

Crag. 1. A fossiliferous sandy marl of marine origin; generally used, capitalized, as part of the names of several formations of Pliocene age in eastern England. (La Forge) 2. A steep, rugged rock; a rough broken cliff or projecting point of rock. 3. A detached fragment of rock. (Webster)

Crampet (Eng.). A bracket (Bainbridge). *See also* Cramp, 3.

Cramp. 1. A short bar of metal having its two ends bent downwards at right angles for insertion into two adjoining pieces of stone, wood, etc., to hold them together. (Duryee) 2. A pillar of rock or mineral left for support. (Weed) 3. (Derb.). A fastening used to keep pumps in place (Hooson). *See also* Clamp, 1.

Crampon. A form of hooked clutch or dog for raising stones, lumber, ice, etc.; grappling irons. (Webster)

Cranch (Derb.). A pillar of ore left to support the roof or hanging wall (Hooson). *See also* Cramp, 2.

Crandall. A mason's tool for dressing stone. (Century)

Crane. A kind of machine for raising and lowering heavy weights, and while holding them suspended, transporting them through a limited lateral distance. (Webster)

Crane board (No. of Eng.). A return air course connected directly with the furnace. (Gresley)

Crane brae (Scot.). A short incline in steep workings. (Barrowman)

Crane ladle. A pot or ladle, supported by a chain from a crane, used for pouring molten metals into molds. (Century)

Crane man. 1. (Eng.) One whose business it is to hoist coal with the crane. (G. C. Greenwell)
2. A man who operates any type of a crane.

Crane post. The upright post on which the arm or jib of a crane works. (Century)

Crank (Wales). Small coal. (Gresley)

Cranny. Any small opening, fissure, or crevice, as in a wall or rock. (Duryee)

Crate dam. A dam built of crates filled with stone. (Duryee)

Crater. The basin-like or funnel-shaped opening which marks the vent of a volcano; also the mouth of a geyser. (Webster)

Craw-coal. *See* Crow-coal.

Craw picker (Scot.). One who picks stones from coal or shale. (Barrowman)

Craza (Mex.). A vessel to receive molten metal. (Dwight)

Craze; Creaze (Corn.). The tin ore which collects in the middle part of the buddle; middlings. (Raymond)

Cream. A rusty impure meerschaum. (Power)

Crease. 1. (Forest of Dean) Mountain limestone workings. (Gresley)
2. An old stream channel. (Lahee, p. 282)

Creaze (Corn.). Middlings. *See* Craze.

Creek. 1. In maritime districts, a small tidal inlet. 2. In inland districts, a small stream or branch of a river; a brook. (La Forge)

Creek claim. A claim which includes the bed of a creek (Duryee). Under the statute of Oregon, a tract of land one hundred yards square, one side of which abuts on a creek or rather extends to the middle of the stream. (Chapman *v.* Toy Long, 4 Sawyer, p. 32; 5 Federal Cas., p. 497)

Creek placers. Placers in, adjacent to, and at the level of small streams. (U. S. Geol. Surv., Bull. 259, p. 33)

Creek right. The privilege of diverting water for the purpose of working a creek claim. (Duryee)

Creel (Scot.). A kind of basket in which coal and rock are conveyed from the mine. (Gresley)

Creep. 1. (Eng.) A squeeze or crush forcing the pillars down into the floor which often gives the miner the impression that the floor is rising, due to its being softer than the roof. Any slow movement of mining ground. Also called Squeeze; Pull. *Compare* Thrust.
2. A gradual movement of loose rock material such as clay, due to alternate freezing and thawing, wetting and drying, or other causes.
3. To rise above the surface of a solution upon the walls of a vessel in which the solution is contained as salt crystals in a voltaic cell. (Webster)
4. A very slow movement of a winding engine, when the brake is not sufficiently applied to hold it. (Gresley)

Creeper chain (Aust.). A strong endless chain, in which every few feet a horn is inserted, which catches the axle of a skip and draws it up an incline. (Power)

Creeping. (Eng.). The settling, or natural subsidence, of the surface, caused by extensive underground workings. (Gresley)

Creeshy bleas. (Scot.). Nodules of bituminous shale in the soft roof of some of the Scotch collieries. So called from the sort of unctuous smoothness, which causes them to fall out when the coal is removed. Also called Greasy bleas. (Gresley)

Creminel (Brit. Guiana). A shovel used by the natives for removing the overburden of placer mines. (Halse)

Crenitic. A word derived from the Greek for spring, and especially used by T. S. Hunt for those rocks, which were thought by him to have come to the surface in solution and to have been precipitated. He used the so-called 'crenitic hypothesis' to explain certain schists whose feldspars were supposed to have been originally zeolites, but his views have received slight, if any, support. Crenitic is also used by W. O. Crosby to describe those mineral veins which have been deposited by uprising springs. (Kemp)

Creosote. 1. An oily antiseptic liquid obtained by the distillation of wood tar. Also a similar substance obtained from coal tar. 2. To saturate or impregnate with creosote, as timber to prevent decay. (Webster)

Crept bord (Eng.). A bord or room more or less filled up from the effects of creep. (Gresley)

Crept pillars (Eng.). Pillars of coal which have passed through the various stages of creep. (G. C. Greenwell)

Cressed. Reduced about ⅛ inch in diameter for a short distance at ends. A foreign term, used on artesian well casing. (Nat. Tube Co.)

Cresset (Eng.). A sort of lamp or torch; an iron basket or vessel for holding burning oil or other illuminant and mounted as a torch. (Webster)

Cresting. Trimming used on the ridge of tiled roofs. Same as Hip roll. (Ries.)

Crestón (Sp.). The outcrop or apex of a vein. (Dwight)

Creta. 1. (Sp.). Fuller's earth. *See* Greda, 1. 2. (Mex.). Impure litharge formed in a reverberatory furnace. (Halse)

Cretaceous. 1. Of the nature of chalk; relating to chalk. (Hitchcock)
2. The third and latest of the periods included in the Mesozoic era; also the system of strata deposited in the Cretaceous period. (La Forge)

Cretacio (Sp.). Cretaceous. (Dwight)

Crevasse. 1. A fissure in the mass of a glacier. 2. A breach in the levee or embankment of a river. (Webster)

Crevet. A crucible. (Raymond)

Crevice (Pac.). 1. A shallow fissure in the bedrock under a gold placer, in which small but highly concentrated deposits of gold are found. 2. The fissure containing a vein. (Raymond). As employed in the Colorado statute relative to a discovery shaft, a crevice is a mineral-bearing vein. (Bryan *v.* McCaig, 10 Colorado, 309; 15 Pacific, p. 413; Beals *v.* Cone, 27 Colorado, 500; 15 Pacific, p. 948; Terrible Mining Co. *v.* Argentine Mining Co., 89 Federal, 583)

Crevicing. Collecting gold that is in the crevices of a rock. (Skinner)

Criadero (Sp.). 1. An ore or mineral deposit. *C. detrítico*, alluvium; *C. en arbol*, ramification; *C. en filón*, a vein deposit of considerable extension; *C. en veta*, a vein deposit of variable but not great dimensions; *C. en capa*, a stratified deposit; *C. en riñones*, small irregular deposits. (Halse)
2. (Mex.) Any mineral deposit. This is the more modern sense, and the word is so used in the mining laws at present (1902) in force in Mexico. (Dwight)

Crib. 1. *See* Curb, 1, Nog, Chock, Pack. 2. A structure composed of frames of timber laid horizontally upon one another, or of timbers built up as in the walls of a log cabin. 3. A miner's luncheon. (Raymond)
4. (Eng.) A cast-iron ring in a shaft upon which tubbing is built up. *See* Wedging curb. 5. (Eng.) A wooden foundation upon which the brick lining or walling of a shaft is built. (Gresley)

Criba (Mex.). 1. Screen or sieve; *C. giratoria*, revolving screen or trommel. *See also* Cedazo. 2. A hand-jig. *See also* Harnero. (Dwight)

Cribado (Sp.). Jigging or screening ore. (Lucas)

Cribador (Mex.). An ore screener. (Dwight)

Cribar (Sp.). To screen, jig, or sift. (Halse)

Cribbing. 1. Close timbering, as the lining of a shaft. (Rowden *v.* Daniel, 151 Missouri App., p. 22)
2. The construction of cribs of timber, or of timber and earth or rock to support the roof. (Steel)

Cribble. A sieve. (Raymond)

Cribwork. A construction of timbering made by piling logs or beams horizontally one above another, and spiking or chaining them together, each layer being at right angles to those above and below it (Century). *See also* Crib, 2.

Crichtonite. A variety of ilmenite in which the proportion of titanic oxide is less than normal. (Standard)

Crilley and Everson process. A flotation process in which the ore is crushed to 50 mesh, and mixed with a thick black oil. Boiling water containing enough acid to give it a tart taste is then added. This process was tried at Baker City, Oreg., and at Denver, Colo., in 1889. (Liddell)

Crimp. The flattening made by a crimper near the mouth of a blasting cap for holding the fuse in place. (Du Pont)

Crimper. A device used for crimping a cap about a piece of fuse. (Gillette, p. 448)

Cripple. 1. Swampy or low wet ground; bog. 2. A rocky, shallow place in a stream. (Webster)

Crisócola (Sp.). 1. Chrysocolla. 2. Gold solder. 3. Borax, (Halse)

Crisol (Mex.). An assay crucible; melting pot; slag pot. (Dwight)

Crisolada (Sp.). 1. A crucible full of molten metal. 2. A crucible charge. (Halse)

Crisolero (Mex.). A slag-pot puller. (Dwight)

Cristal (Sp.). A crystal; *C. de roca*, rock crystal. (Halse)

Cristalino (Sp.). Crystalline. (Dwight)

Cristo-grahamite. Grahamite from the Cristo mine, Huasteca, Mexico. (Bacon)

Critical angle. The least angle of incidence at which total reflection takes place. (Webster)

Critical density. The density of a substance at its critical point. (Webster)

Critical pressure. The pressure necessary to raise the boiling point of a substance, in the liquid state, to the critical temperature; the pressure that will just liquefy gas at its critical temperature. (Webster)

Critical temperature. Any temperature marked by a transition; the temperature above which a substance can exist only in the gaseous state, no matter what the pressure. (Webster)

Crocidolite. Blue asbestos. One of the monoclinic amphiboles. (Dana)

Crocoite. Lead chromate, $PbO.CrO_3$. Contains 68.9 per cent PbO and 31.1 per cent CrO_3. (U. S. Geol. Surv.)

Crocus. A term used in the Milford, N. H., quarries to denote gneiss or any other rock in contact with granite. (Perkins)

Cromo (Sp.). Chromium. (Dwight)

Cronstedite. A coal-black to brownish-black hydrous iron silicate, $4FeO.2Fe_2O_3.3SiO_2.4H_2O$. (Dana)

Crookesite. A massive, compact metallic, lead-gray selenide of copper, thallium and silver, $(Cu,Tl,Ag)_2Se$. (Dana)

Crop. 1. *See* Outcrop; *also* Bassett. 2. The roof coal or stone which has to be taken down in order to secure a safe roof in the workings. (Gresley)
3. (Corn.) *See* Crop-tin. 4. To leave coal at the bottom of a bed. (Raymond). *See* Cropping coal.
5. (Eng.) To dock or fine by deducting a certain portion of the weight of coal in the car when there is an excess of refuse, or the like. (Webster)

Crop coal. Coal of inferior quality near the surface. (Roy. Com.)

Crop fall. A caving in of the surface at the outcrop of the bed caused by mining operations. Applied also to falls occurring at points not on the outcrop of the bed. Synonomous with Day fall. (Chance)

Crop ore (Local Eng.). First-quality tin ore, cleaned for smelting. (Standard)

Crop out. To be exposed at the surface; referring to strata (Whitney). *See also* Outcrop.

Cropper (Eng.). A shot placed at the highest side or edge of a shaft bottom. (Gresley)

Cropping. An outcrop. (Standard)

Cropping coal. The leaving of a small thickness of coal at the bottom of the seam in a working place, usually in back water. The coal so left is termed "Cropper coal." (C. and M. M. P.)

Cropping out. The natural exposure of bedrock at the surface. That part of a vein which appears at the surface is called the cropping or outcrop. (Raymond)

Croppings. Portions of a vein as seen exposed at the surface. (C. and M. M. P.)

Crop tin. The chief portion of tin ore separated from waste in the principal dressing operation. (Raymond)

Crop upwards (Eng.). In miners' parlance, to rise. (Roberts)

Croquis (Sp.). A sketch; a rough draft. (Halse)

Cross (Wales). *See* Crosscut.

Crossbar. A horizontal timber held against the roof to support it, usually over a roadway; a collar. (Steel)

Cross-bedded. Characterized by minor beds or laminæ oblique to the main stratification; cross-stratified. (Webster)

Cross-bedding. Lamination, in sedimentary rocks, confined to single beds and inclined to the general stratification (La Forge). Caused by swift, local currents, deltas, or swirling wind-gusts, and especially characteristic of sandstones, both aqueous and eolian. (Kemp)

Cross course. A seam, bar or belt of rock, not necessarily a lode, crossing a lode (Webster). A contra-lode.

Cross-course spar (Corn.). Radiated quartz. (Whitney)

Crosscut. 1. A small passageway driven at right angles to the main entry to connect it with a parallel entry or air course. Also used in Arkansas instead of "breakthrough." (Steel)
2. A level, driven across the course of a vein or in general across the direction of the main workings or across the "grain of coal." (Raymond)

Crosscut method (combined with removal of pillars). *See* Top slicing and cover caving.

Crosscut method of working. *See* Overhand stoping.

Crosscut tunnel. A tunnel driven at approximately right angles to a main tunnel, or from the bottom of a shaft or other opening, across the formation to an objective point (Duryee). The term "crosscut" would seem more appropriate as the term tunnel implies being open to the surface at both ends, as a railroad tunnel.

Crossed dispersion. In optical mineralogy, the dispersion that produces an interference figure with color distribution symmetrical to the center of the figure. (A. F. Rogers)

Crossed nicols. Two nicol prisms placed so that their vibration planes are mutually at right angles. (Luquer, p. 26)

Crossed twinning. Repeated twinning after two laws. Shown in microcline. (Luquer, p. 37)

Cross entry. An entry running at an angle with the main entry. (Roy)

Crosses and holes (Derb.). In Derbyshire the discoverer of a lode secures it temporarily by making "crosses and holes" in the ground. (Davies)

Cross fault. An oblique or dip fault. (Webster)

Cross flucan. A name given by Cornish miners to clay veins of ancient formation (Ure). *See also* Flucan.

Cross frog. A frog adapted for railroad tracks that cross at right angles. (Webster)

Cross gates (York). Short headings driven on the strike and at right angles to the main gates or roads. (Gresley)

Cross gateway (Aust.). A road, through the goaf, that branches from the main gateway. (Power)

Cross-grained rock (Ohio). A local term for certain sandstone beds that exhibit cross bedding. (Bowles)

Crosshead. 1. A runner or framework that runs on guides, placed a few feet above the sinking bucket in order to prevent it from swinging too violently. (Power)
2. A beam or rod stretching across the top of something; specifically, the bar at the end of a piston rod of a steam engine, which slides on the ways or guides fixed to the engine frame and connects the piston rod with the connecting rod. (Century)

Cross-head guide. A guide for making the crosshead of an engine move in a line parallel with the cylinder axis. (Standard)

Cross heading. A passage driven for ventilation from the airway to the gangway, or from one breast through the pillar to the adjoining working (Chance). Also called Cross hole, Cross gateway, and Headway.

Cross hole (Wales). A short cut-through communicating with two headings, for ventilation purposes. (Gresley)

Crossing. 1. The place where two or more lines of rails extending in different directions cross each other. (Power)
2. (Eng.) *See* Air crossing. 3. (Wales) A crosscut. (Gresley)

Crossite. A blue amphibole found in the crystalline schists of California. (Standard)

Cross latches. *See* Latches, 1.

Cross lode. A vein intersecting the true or principal lode (Webster). *See* Cross-vein.

Cross-measure. A heading driven horizontally or nearly so, through or across inclined strata. (Gresley)

Cross-off (Clev.). *See* Stack out.

Crossover. A short connecting track with a switch and frog at each end, by which trains, (or cars) may be switched from either of two tracks to the other. (Webster)

Crosspiece. The short pieces of timber in a wooden pillar or crib. *See* Edgers. (Sanders, p. 115)

Crossroad (Scot.). A main road driven at a more moderate inclination than directly to the rise of the strata. (Barrowman)

Cross section. A cutting or section across; a section at right angles to an axis, especially the longer axis of anything; also a piece of something cut off in a direction at right angles to an axis. (Webster)

Cross-spur. A vein of quartz that crosses a lode. (C. and M. M. P.)

Cross-stone. A synonym for Andalusite. (Chester)

Cross stoping. *See* Overhand stoping.

Cross-stratification. In geology, the condition of having the minor laminations oblique to the plane of the main stratum which they help to compose. (Standard). *See also* Cross-bedding.

Crosstie. A timber or metal sill placed transversely under the rails of a railroad, tramway or mine-car track.

Cross vein. 1. An intersecting vein (Raymond). *See* Cross lode.
2. A vein which crosses the bedding planes of the strata. This usage appears unnecessary, and conflicts with the same name applied to cases where two veins actually cross each other. (Shamel, p. 165)

Crouan (Corn.). Granite. (C. and M. M. P.) *See also* Grouan.

Crouch clay (Eng.). An old name for the white Derbyshire clay. (Century)

Crouch ware. 1. (Staff.) A kind of fine pottery made in the seventeenth century. 2. A salt-glazed stoneware made at Burslem, England. (Century)

Crow-coal. Certain earthy coal which contains very little bitumen and a large percentage of ash (Power). Also called Craw-coal, and Craws.

Crowfoot; Crow. 1. A tool with a side-claw, for grasping and recovering broken rods in deep bore-holes. (Raymond)
2. An iron claw or fork, to which a rope is attached, and by which the rods are lowered and raised when changing the tools in deep bore holes. (Gresley)
3. (Tenn.) Zigzag, wavy or irregular, dark lines characteristic of Tennessee marble. (Bowles)

Crown arch. The arched plate which supports the crown-sheet of the fire box of a boiler. (Century)

Crown bar. One of the bars on which the crown-sheet of a locomotive rests. (Century)

Crown formation (Aust.). A term used in Bendigo for the outcrop of saddle reefs crowning the hills, from which points the reefs dip in opposite directions. (Power)

Crown-gate. The head gate of a canal lock. (Century)

Crown gold. Gold eleven-twelfths (.917) fine, the standard for English gold coins since Charles II. (Webster)

Crown-in (Ches.). The caving of the surface or cover of a rock-salt mine. (Gresley)

Crownings-in (So. Staff.). The strata forming the roof or cover. (Gresley)

Crown sheet. The flat plate which forms the top of the furnace or fire box in an internally fired steam boiler. (Webster)

Crownstone. 1. No. of Eng.) The top stone of the gable-end of a house. 2. A hard, smooth, flinty gritstone (Century). *See also* Ganister, 3.

Crown tree; Crown. A piece of timber set on props to support the mine roof. (C. and M. M. P.)

Crown wheel. A cog-wheel having the teeth on the plane of the wheel's circle instead of upon its circumference. (Duryee)

Croylstone. A variety of finely crystallized barite. (Standard)

Crozle; Crozzle. To cake or harden with heat; to burn to a cinder. A cinder (Webster). Said of coal.

Crucero (Sp.). 1. Crosscut. 2. A cross course; a cross-vein. 3. End pieces of a set of shaft timbers. (Halse)

Cruceros. 1. (Chile) Minute veins, oblique to the lode, in both direction and dip, being the largest and richest at the junction. 2. (Spain) The two cross beams of the pulley frame of a *malacate*. (Halse)

Cruces (Sp.) The crosspieces of an arrastre or grinding mill. (Min. Jour.)

Crucible. 1. A melting pot. 2. The lower part of a shaft furnace, in which fusion is effected and the molten bath is contained. (Raymond)

Crucible steel. Also crucible cast steel. A superior but expensive kind of cast steel made by either melting blister steel in crucibles, or by fusing together wrought iron, carbon and flux in crucibles. (Webster)

Crucite. Same as Andalusite. (Standard)

Crude. 1. In a natural state; not altered, refined or prepared for use by any process, as crude ore. (Webster)
2. A name for crude petroleum. (Bacon)

Crude oil. A name for crude petroleum. (Bacon)

Crude mineral-oil. A name for crude petroleum. (Bacon)

Crude naphtha. Unrefined petroleum-naphtha. (Standard)

Crude ore-bin. An ore bin of crude construction. (Rickard)

Crude-ore bin. A bin in which ore is dumped it comes from the mine. (Rickard)

Crup. A gradual settling of the measures overlying a mine caused by the weight crushing the pillars, or forcing them down into the floor (Harr). A variation of creep.

Crusader. A wooden sailing ship of 643 tons register. One of the first sailing vessels to be converted into oil carriers in 1885. The Crusader was fitted with 47 independent tanks, arranged in three superimposed tiers, an arrangement which was found to work satisfactorily. (Mitzakis)

Crush. 1. A general settlement of the strata above a coal mine due to failure of pillars; generally accompanied by numerous local falls of roof in mine workings. 2. A species of fault in coal. (Century)

Crush-border. A microscopic granular structure sometimes characterizing adjacent feldspar particles in consequence of their having been crushed together during or subsequent to their crystallization. (Dale)

Crush breccia. A breccia produced by the shattering of rocks along a fault. (Century)

Crushed steel. Angular fragments of hard steel employed as an abrasive in sawing stone. (Bowles)

Crushed vein. A mineralized zone or belt of crushed material. The crushing is due to folding, faulting, or shearing.

Crusher. A machine for crushing rock or other materials (Webster). As a gyratory crusher, jaw crusher, stamp mill, etc.

Crusher rolls. *See* Rolls.

Crush-conglomerate. A conglomerate produced by the crushing of certain rocks in the shearing movements following folding. (Standard)

Crushing. 1. Reducing ore or quartz by stamps, crushers, or rolls. (Roy. Com.)
2. The quantity of ore so pulverized or crushed at a single operation. (Hanks)
3. (Aust.) The equivalent of "mill-run." (Power)

Crushing machine. A machine constructed to pulverize or crush stone and other hard and brittle materials; a stone crusher. (Century)

Crushing mill. The same as Stamp mill (Winchell). *See* Crusher.

Crushing rolls. A machine consisting of two heavy rolls between which ore, coal or other mineral is crushed. Sometimes the rolls are toothed or ribbed, but for ore their surface is generally smooth. (Century)

Crushing strength. The resistance which a rock offers to vertical pressure placed upon it. It is measured by applying graduated pressure to a cube, one inch square, of the rock tested. A crushing strength of 4,000 pounds means that a cubic inch of the rock withstands pressure to 4.000 pounds before crushing (Lowe). The crushing strength is greater with shorter prisms, and less with longer prisms.

Crush line. In geology, a line along which rocks, under great compression, yield, usually with the production of schistosity. (Century)

Crush movement. In geology, compression, thrust, or lateral movement tending to develop shattered zones. (Century)

Crush plane. In geology, a plane defining zones of shattering which result from lateral thrust. (Century)

Crush zone. In geology, a zone of faulting and brecciation in rocks. (Century)

Crust. 1. The hard external covering of anything. An incrustation. (Webster)
2. The lithosphere, or solid exterior portion of the earth, whose nature is partly known from geologic examination, or highly probable deduction; contrasted with the enveloping hydrosphere and atmosphere and with the unknown centrosphere or barysphere, whose nature is conjectural. (La Forge)
3. (Shrop.) A fine-grained white sandstone. (Gresley)

Crust fracture. An extended fracture in the earth's crust. (Century)

Crustification. The English equivalent of a term suggested by Posepny for those deposits of minerals and ores that are in layers or crusts and that, therefore, have been distinctively deposited from solution. (Kemp)

Crust movement. An extensive movement of the earth's crust. (Century)

Crust-stress. Local strains and pressure within the rocks of the earth's crust. (Century)

Crust-torsion. A twisting stress in the earth's crust. (Century)

Crutt (No. Staff.). *See* Branch, 1 and 2.

Cruz (Sp.). 1. Cross. 2. Intersection of two ways. 3. Arms of a scale. (Dwight)
4. A wall which divides the bed of Spanish reverberatory furnaces. (Halse)

Cruzada (Colom.). A crosscut. (Halse)

Cruzado (Sp.). A lode or vein which is crossed by another. *See also* Cruzador. (Halse)

Cruzador (Colom.). 1. A cross vein or lode. 2. A vein crossed by another. (Halse)

Cruzamiento (Sp.). 1. A crossing of underground roads. 2. A crossing of air currents; an overcast. 3. The crossing of two veins. (Halse)

Cry of tin. The peculiar crackling noise produced in bending a piece of metallic tin. (Raymond)

Cryolite. A fluoride of sodium and aluminum, $3NaF.AlF_3$. (U. S. Geol. Surv.)

Cryolite glass. A semi-transparent or milky-white glass, made of silica and cryolite with oxide of zinc, melted together. Also called Milk glass and Fusible porcelain. (Century)

Cryptoclastic. Compact. Made of extremely minute fragmental particles. (Webster)

Cryptocrystalline. Formed of crystals of unresolvable fineness, but not glassy. (Kemp)

Cryptographic. In petrology, having a graphic structure of intergrowths so minute that it can not be resolved by a microscope. (Standard)

Cryptohalite. A gray ammonium fluosilicate $(NH_4)_2.SiF_6$, that crystallizes in the isometric system. (Standard)

Cryptoperthite. A variety of perthite with structure so fine that it can not be discerned by the microscope. (Standard)

Crys ground (Forest of Dean). Carboniferous limestone strata containing beds of iron ore. (Gresley)

Crystal. A regular polyhedral form, bounded by planes, which is assumed by a chemical element or compound, under the action of its intermolecular forces, when passing, under suitable conditions, from the state of a liquid or gas to that of a solid. A crystal is characterized, first, by its definite internal molecular structure, and, second, by its external form. (Dana)

Crystallized tin plate. Tin plate having crystals formed by the action of diluted nitric and hydrochloric acids (Standard). A rather low grade of tin plate. *See* Tin plate.

Crystalliform. Having a crystalline form. (Standard)

Crystalline. Of or pertaining to the nature of a crystal, having regular molecular structure. (Webster)

Crystalline aggregate. An aggregate of crystalline grains or fragments, as granite not showing well-defined crystal forms. (Webster)

Crystalline limestone. Limestone composed largely or wholly of crystallized material, commonly as the result of metamorphism. (La Forge)

Crystalline rock. A rock composed of closely fitting mineral crystals that have formed in the rock substance, as contrasted with one made up of cemented grains of sand or other material or with a volcanic glass. (Standard)

Crystalline schists. Rocks that have been entirely or partly recrystallized by metamorphism. They are named after their predominating mineral, as chlorite-schist, hornblende-schist, mica-schist, etc. (Standard)

Crystalline metamorphism. A molecular change which renders an amorphous mineral body crystalline; as limestone to marble. (Sloan)

Crystallites. Small, rudimentary or embryonic crystals, not referable to a definite species. (Kemp)

Crystallitic. In petrology, of the nature of or belonging to the class of crystallites. (Standard)

Crystallization. The act or process of crystallizing. A form or body resulting from this act or process. See Crystallization systems. (Webster)

Crystallization systems. The thirty-two possible crystalline groups, distinguished from one another by their symmetry, are classified under six systems, each characterized by the relative lengths and inclinations of the assumed crystallographic axes. These are: (1) Isometric; (2) Tetragonal; (3) Hexagonal; (4) Orthorhombic; (5) Monoclinic; (6) Triclinic. (Dana)

Crystallize. To convert into a crystal; to deposit crystals (Webster). To solidify, from a liquid or gaseous state, in a crystalline form, with a regular molecular structure. (La Forge)

Crystalloblastic. A structure in schists due to relative perfection of crystal forms and arrangement. (Leith, p. 77)

Crystallogeny. The science and theory of the production of crystals. (Standard)

Crystallography. The science of crystals treating of the system of forms among crystals, their structure, and their forms of aggregation. A discourse or treatise on crystallization. (Webster)

Crystalloid. A substance which, in solution, diffuses readily through animal membranes, lowers the freezing point of the solvent, and generally is capable of being crystallized. Opposed to colloid (Webster). Metallic salts, sugar, oxalic acid are crystalloids.

Crystallology. The science of the structure of crystals. It embraces crystallography and crystallogeny. (Standard)

Crystallurgy. The process of crystallization. (Century)

Crystal optics. The science which treats of the transmission of light in crystals. (A. F. Rogers)

Crystolon. A trade name for carbide of silicon. (Pike)

Cuadrilla (Mex.). 1. A settlement. *Compare* Pueblo. (Lucas)
2. A gang or crew of laborers. (Halse)

Cuadro (Sp.). 1. A square set for stopes. 2. A block of ground ready for stoping. 3. (Colom.) A bunton, also a timber 5 to 20 in. square. (Halse)

Cuajado (Mex.). 1. Argentiferous carbonate of lead. 2. Coarse galena. (Halse)

Cuarcita (Mex.). Quartzite. (Dwight)

Cuarteador (Colom.). The miner who works *cuarteo*, 3. (Halse)

Cuarteadura (Mex.). A fissure in rocks. (Halse)

Cuartear (Sp.). To break large stones with a sledge hammer. (Halse)

Cuartel (Colom.). 1. Barracks for miners. 2. An underground section, district or group of workings. (Halse)

Cuarteo (Colom.). 1. A transitory suspension of the rains in winter. 2. A night shift of peons. 3. A system of working mines by which the ore is bought of the miners by the company, the miners providing the supplies. (Halse)
4. (Mex.) Work on drill holes, paid for by the foot, yard, meter, etc. (Dwight)

Cuarto. 1. (Mex.) A shift; *C. primero*, day-shift; *C. segundo*, afternoon-shift; *C. tercero*, night-shift. (Dwight)
2. (Sp.) A room in a mine for keeping tools, lights, etc. 3. (Mex.) *Minero de C.*, an underground mine captain. 4. (Colom.) Overtime. (Halse)

Cuartón (Mex.). A large bowlder. (Dwight)

Cuarzo (Sp.). Quartz; *C. ahumado*, smoky quartz; *C. furuginoso*, ferruginous quartz; *C. lechoso*, milky quartz; *C. porfídico*, (Peru) hornstone; *C. Rosado*, rose quartz. (Halse)

Cuaternario (Sp.). Quaternary. (Dwight)

Cuba (Sp.) 1. A keeve, vat. 2. A kibble. 3. An amalgamation barrel. 4. Shaft, fire room, or tunnel of a blast or shaft furnace. 5. The fire room of a coke oven. (Halse)

Cubanite (Cuba). A bronze-yellow sulphide of copper and iron mineral, perhaps $CuFe_2S_4$ or $CuS.Fe_2S_3$. (Dana)

Cubbling. Breaking up pieces of flat iron to be piled or fagoted, heated and rolled. (Raymond)

Cube. 1. In crystallography, a form, in the isometric system, inclosed by six similar faces each of which is perpendicular to an axis. (La Forge)
2. (Scot.) A ventilating furnace in a mine. (Barrowman)

Cube coal. 1. A layer of hard greenish clay found at the top of a coal seam in parts of Pennsylvania and West Virginia. It breaks readily into cubes of nearly perfect shape. Sometimes called Rooster coal. 2. (Eng.) Coal broken into cubes, of about one foot on each side, to suit certain trade. (Gresley)

Cube ore (Eng.). An arsenate of iron, $6FeAsO_4.2Fe(OH)_3+12H_2O$, of an olive-green to yellowish brown color, and occurring commonly in cubes with the copper ores of Cornwall and other localities. Pharmacosiderite. (Dana)

Cube powder. Gunpowder made in large cubical grains and burning more slowly than the small or irregular grains. (Century)

Cube spar. Same as Anhydrite. (Standard)

Cubeta (Mex.). Bucket (Dwight). A small barrel or cask.

Cubical cleavage. Equally good cleavage in three mutually perpendicular directions. (Butler)

Cubicite; Cubizite. Cubic zeolite, or analcime. (Century)

Cúbico (Sp.). Cubic. (Dwight)

Cubic stock. Blocks of stone approximately cubical in form as contrasted with thin stock or slabs. (Bowles)

Cubierto (Sp.). 1. The bonnet of a safety cage. 2. The overburden of a placer mine. 3. The outer jacket of a furnace. (Halse)

Cubilete (Sp.). A kind of shallow bucket for hoisting ore. (Halse)

Cubilote (Sp.). A cupola smelting furnace; a smelting pot. (Halse)

Cubo (Mex.). 1. Bucket; kibble. 2. The third power of a number. (Dwight)

Cuchara (Peru). 1. A spoon; ladle; scraper. 2. A utensil made of horn, in which minerals are washed as a rough test of value. 3. (Mex.) Blade of water wheel. (Dwight)

Cucharilla (Mex.). An iron rod, used in drilling, to remove drill cuttings from a dry hole. (Dwight)

Cucurucho (Mex.). A leather cover to protect miners at work from falling water or rocks. (Dwight)

Cuddy. 1. (Scot.) A donkey. 2. A lever mounted on a tripod for lifting stones, leveling up railroad ties, etc. (Webster)
3. A weight mounted on wheels; a loaded bogie, used to counter balance the tub or car on an inclined roadway (Barrowman). Also spelled Cuddie.

Cuddy brae (Scot.). An inclined roadway, worked in the same manner as a self-acting incline. (Barrowman)

Cuele (Mex.). 1. The distance a tunnel or other work is extended during a certain time. (Dwight)
2. The bottom of a shaft. (Halse)

Cuenca (Mex.). 1. Broad valley. 2. Geological basin (Dwight). *C. carbonifera*, a coal measure or basin. (Halse)

Cuenta (Sp.). A lenticular mass of ore. (Halse)

Cuerda (Sp.). 1. A cord or small rope. 2. (Mex.) Limits of a mining property. 3. (Mex.) A row of men who pass blocks of ore from hand to hand. 4. A cord of firewood. (Halse)

Cuero (Sp.). 1. A hide, generally of oxen, cows, etc. (Halse).
2. (Mex.) A leather bucket. (Dwight)

Cuerpo. 1. (Peru and Mex.) An ore body. 2. A mass of pulp in process of amalgamation (Dwight)
3. (Mex.) A globule of mercury. 4. *C. del alto*, the hanging-wall branch of a vein; *C. del medio*, the center branch of a vein; *C. del bajo*, the foot-wall branch of a vein. 5. *C. de mineros*, the personnel of a mine. (Halse)

Cuesco (Mex.). Coarse ore; a recemented, fragmentary rock. (Dwight)

Cuesta (Sp.). A sloping plain, especially one with the upper end at the crest of a cliff; a hill or ridge with one face steep and the opposite face gently sloping. Common in Southwestern United States. (Webster)

Cueva (Sp.). 1. A cave or grotto. 2. (Spain) Old Roman shafts and headings, sometimes full of water and running sand or mud. 3. (Colom.) Placer gravel covered by large blocks of granite making its extraction very laborious. (Halse)

Cuffat (Fr.). A vessel consisting of a shallow tub fitted with 4 wheels and attached to chains at the sides for hoisting coal. The coal is piled in a conical form and kept from falling off by iron rings placed one above another. (Gresley)

Cui (Fr. Guiana). A hemispherical vessel made of tin plate, used in draining placers. (Halse)

Cuiller (Fr.). A long, wrought-iron, cylindrical bucket in which waste from shaft sinking is brought to the surface. (Gresley)

Cuinage (Eng.). The official stamping of pigs of tin for market (Standard). A corruption of coinage.

Culbuteur (Belg.). A dumping apparatus which turns completely over, or around, when emptying cars. (Gresley)

Culet. The small, lower terminus, of a brilliant-cut gem, parallel to the table. (Standard)

Culm. 1. (Eng.) Anthracite. (Welsh) A kind of coal, of indifferent quality, burning with a small flame, and emitting a disagreeable odor. (Humble)
2. (Penn.) The waste or slack of the Pennsylvania anthracite mines, consisting of fine coal, more or less pure, and coal dust and dirt. (Raymond)
3. In the usage of many European authors, the Lower Carboniferous or Dinantian series of the Carboniferous system of rocks in western Europe, especially where consisting largely of siliceous beds with little limestone (La Forge). Called in Ireland, Calp.

Culm bank; Culm dump. A heap or pile of waste kept separate from the rock and slate dumps. *See* Culm, 2. (Chance)

Culm bar. A peculiar bar used in grates designed for burning culm or slack coal. (Century)

Culmiferous. Containing culm, as coal. (Standard)

Culmophyre. A rock in which the phenocrysts are arranged in clusters or irregular groups. (Iddings, p. 224)

Culo (Sp.). The lower or inner part of a drill hole. (Halse)

Cumberlandite. A name derived from Cumberland Hill, R. I., proposed by Wadsworth for the ultra-basic, igneous rocks, forming the hill. It is an aggregate of titaniferous magnetite, plagioclase, olivine and secondary minerals, but contains from 40–45 per cent iron oxides and about 10 per cent TiO_2. (Kemp)

Cumberland method of mining. *See* Top slicing and cover caving. *Also* Top slicing combined with ore caving.

Cumbre (Sp.). Top or summit of a mountain or hill. (Halse)

Cumene. A hydrocarbon, C_9H_{12}, first found by De la Rue and Muller in Rangoon oil. (Mitzakis)

Cumulites. Vogelsang's name for spherulitic aggregates of globules. (Kemp)

Cumulose deposits. Peat, muck and swamp soils in part. (Watson)

Cuna (Sp.). A cradle used in gold washing. (Halse)

Cuña. 1. (Sp.) A wedge or gad. 2. (Sp.) A "horse" of ground. 3. (Colom.) Pillars left in stopes for supporting the main levels. (Halse)

Cundy; Cundie. 1. (Scot.) The spaces from which coal has been worked out, partly filled with dirt and rubbish between the packs (Gresley). *See* Goaf.
2. (Aust.) The passage under a roadway into which an endless rope

passes out of the way at the end of its track. Also called Conduct (Power). A variation o fConduit.

Cuneta (Sp.). 1. A small trench. 2. The drain or gutter of an adit level or gangway. (Halse)

Cup-and-cone. A machine for charging a shaft furnace, consisting of an iron hopper with a large central opening, which is closed by a cone or bell, pulled up into it from below. In the annular space around this cone, the ore, fuel, etc., are placed; then the cone is lowered to drop the materials into the furnace; after which it is again raised to close the hole. (Raymond)

Cupel. A small, shallow, porous cup, especially of bone ash: used in assaying to separate precious metals from lead, etc.; also a larger form for commercial refining. (Webster)

Cupel dust. A powder used in purifying metals; also called Coppel dust. (Century)

Cupellation. 1. The treatment on a hearth or cupel (usually formed of bone ash) of an alloy of lead, gold, and silver, by means of fusion and an air blast, which oxidizes the lead to litharge, and removes it in liquid form, or absorbs it in the cupel. (Raymond)
2. As applied to lead smelting, it is the final separation of lead and silver, and consists in melting and heating in a reverberatory furnace argentiferous lead with access of air to the temperature at which litharge forms on its surface. (Hofman, p. 506)

Cúpola (Sp.). A cupelling furnace. (Halse)

Cupola. 1. A shaft furnace with a blast, for remelting metals, preparatory to casting. Sometimes incorrectly pronounced and written Cupelo. (Raymond)
2. The offtake for smoke and return air erected at or near to the top of the upcast shaft. (Gresley)
3. A domical-shaped projection of igneous material from a batholith. Many stocks are cupolas on batholiths. (Daly, p. 102)
4. A circular kiln, with a domed roof, used for burning brick. (Webster)

Cupola furnace. A shaft furnace built more slightly than the ordinary blast furnace, and usually of fire brick, hooped or cased with iron. It is chiefly used for remelting cast-iron for foundry purposes. (Century). *See* Cupola, 1.

Cupriferous. Copper-bearing. The Nipigon or Keweenawan formation. (Winchell)

Cuprita (Sp.). The mineral cuprite. (Dwight)

Cuprite. Native red copper oxide, Cu_2O. Contains 88.8 per cent copper. (U. S. Geol. Surv.)

Cuproapatite. A variety of apatite from Chile containing copper. (Standard)

Cuprotungstite. A tungsten-bearing mineral, $CuWO_4+2H_2O$, also $(CaCu)WO_4+2H_2O$. Its composition is variable, and it may easily be mistaken for some mineral of the epidote group.

Cuprous. Of, pertaining to, or containing copper. (Webster)

Cuprum. Copper; the chemical symbol is Cu.

Cúpula, cúpola (Sp.). The cap or dome of a reverberatory furnace; steam dome of a boiler, etc. (Halse)

Curador (Mex.) A guardian of property; trustee. (Dwight)

Curb. 1. A timber frame, circular or square, wedged in a shaft to make a foundation for walling or tubbing, or to support, with or without other timbering, the walls of the shaft. (Raymond)
2. The heavy frame or sill at the top of a shaft. (Steel)
3. In tunnel construction a ring of brickwork or of cast iron, at the base of a shaft, surmounting a circular orifice in the roof of the tunnel. A Drum-curb, is a flat ring of cast iron for supporting the brickwork, having the same diameter externally as the shaft of brickwork. Temporary curbs of oak are also used. (Simms)
4. An iron border to the incorporating bed of a gunpowder mill. 5. An iron casing in which to ram loam molds for casting. 6. The walls of a chamber in which sulphuric acid is made. (Webster)

Curbing. *See* Curb, 1; Crib, Cribbing and Back-casing.

Curb tubbing (Eng.). Solid wood tubbing. (Gresley)

Curf (Som.). The floor of an underground road which is being taken up. *See also* Canch. (Gresley)

Curi (Ecuador). Gold, hence the Curaray river. (Halse)

Curie point. The temperature lying above the red heat, at which certain bodies, such as iron, nickel, magnetite, etc., lose the property of ferromagnetism and become paramagnetic. (Webster)

Curie's law. The law, established by Pierre Curie, that magnetic susceptibility is inversely proportional to the absolute temperature. (Webster)

Curley cannel (Eng.). Cannel coal which breaks with a conchoidal or curly fracture. (Gresley)

Curlstone (Shrop). Ironstone exhibiting cone-in-cone formation. (Gresley)

Curly shale. 1. (Scot.) A Pumpherston oil shale. Its thickness is about 6 ft. and it yields 20 gal. of crude oil and from 60 to 70 lb. of ammonium sulphate per ton. (Bacon)
2. (U. S.) Any folded and distorted oil shale.

Current. 1. A body of fluid moving continuously in a certain direction, as a current of water or air. 2. A movement of electricity analogous to the motion of a stream of water or other liquid. (Webster)

Current bedding. *See* False bedding.

Current density. The amount of electric current per unit of cross-section area of the conductor, at any part of the circuit. (Webster)

Current meter. 1. An instrument, as a galvanometer, for measuring the strength of an electric current. (Standard)
2. Any instrument for measuring the velocity force, etc., of currents. (Webster)

Curry pit (Leic.). A hole sunk from an upper to a lower portion of a thick seam of coal through which the return air passes from the stalls to the airway. (Gresley)

Curtain. A sheet of brattice cloth hung across an entry in such a way that it prevents the passage of the air current but does not hinder the passage of mules or mine cars. (Steel)

Curtain of coal (West Penn.). A thin pillar left in lieu of timbers for support. It also has the advantage of being a permanent wall and thus assists in directing ventilation.

Curtir (Sp.). The operation of adding lime to warm ores, or magistral to cold ores in amalgamation. (Min. Jour.)

Curva (Mex.) Curve. (Dwight)

Cuselite. Rosenbusch's name for a peculiar variety of augite-porphyrite from Cusel, in the Saar basin. Germany. (Kemp)

Cushioned hammer. A power-hammer striking a cushioned blow. (Standard)

Cut. 1. To intersect a vein or working. 2. To excavate coal. (Raymond)
3. To shear one side of an entry or crosscut by digging out the coal from floor to roof with a pick (Steel). *See also* Undercut, 1.
4 (Som.). A staple or drop-pit, which *see*. 5. (Scot.). *See* Buttock.
6. (Eng.). The depth to which a drill hole is put in for blasting. (Gresley)
7. A term applied where the cutting machine has cut under the coal to a depth of five feet and for a width of fifteen feet. (Stratton v. Northeast Coal Co., 164 Kentucky, p. 302)

Cut chain (Scot.). A system of working underground self-acting inclined planes from several different levels, by means of chains of various lengths which are regulated according to the level from which coal is lowered. (Gresley)

Cut-chain brae (Scot.). An incline on which cut chains are used. (Barrowman)

Cut coal (Scot.). In stoop-and-room working, coal cut on two sides where two rooms at right angles to each other just meet. (Barrowman)

Cut holes. The first round of holes fired in a tunnel or shaft (Du Pont). They are so placed as to force out a cone-shaped core in the center of a heading, and relieve the burden on the second round of shots.

Cut-off. 1. A quarryman's term for the direction along which the granite must be channeled, because it will not split. Same as Hard way. (Perkins)
2. The new and relatively short channel formed when a stream cuts through the neck of an oxbow. 3. The act of shutting off the admission of steam to an engine; also the mechanism for effecting this cut-off at the proper point in the cycle. (Webster)
4. *See* Cut-off entry.

passes out of the way at the end of its track. Also called Conduct (Power). A variation o fConduit.

Cuneta (Sp.). 1. A small trench. 2. The drain or gutter of an adit level or gangway. (Halse)

Cup-and-cone. A machine for charging a shaft furnace, consisting of an iron hopper with a large central opening, which is closed by a cone or bell, pulled up into it from below. In the annular space around this cone, the ore, fuel, etc., are placed; then the cone is lowered to drop the materials into the furnace; after which it is again raised to close the hole. (Raymond)

Cupel. A small, shallow, porous cup, especially of bone ash: used in assaying to separate precious metals from lead, etc.; also a larger form for commercial refining. (Webster)

Cupel dust. A powder used in purifying metals; also called Coppel dust. (Century)

Cupellation. 1. The treatment on a hearth or cupel (usually formed of bone ash) of an alloy of lead, gold, and silver, by means of fusion and an air blast, which oxidizes the lead to litharge, and removes it in liquid form, or absorbs it in the cupel. (Raymond)
2. As applied to lead smelting, it is the final separation of lead and silver, and consists in melting and heating in a reverberatory furnace argentiferous lead with access of air to the temperature at which litharge forms on its surface. (Hofman, p. 506)

Cúpola (Sp.). A cupelling furnace. (Halse)

Cupola. 1. A shaft furnace with a blast, for remelting metals, preparatory to casting. Sometimes incorrectly pronounced and written c pelo. (Raymond)
2. The offtake for smoke and retu air erected at or near to the top the upcast shaft. (Gresley)
3. A domical-shaped projection Igneous material from a batholi Many stocks are cupolas on bat liths. (Daly, p. 102)
4. A circular [illegible] with a [illegible] roof, used fo[illegible] brick. (W ster)

Cupola furn[illegible] furnace [illegible] the [illegible] more [illegible] usually [illegible] blast. [illegible] brick, [illegible] used with [illegible]

It is chiefly used for remelting iron for foundry purposes. tury). *See* Cupola, 1.

Cupriferous. Copper-bearing. Nipigon or Keweenawan f. (Winchell)

Cuprita (Sp.). The mine: (Dwight)

Cuprite. Native red c Cu₂O. Contains 88.8 per. (U. S. Geol. Su

Cuproapatite. A vari from Chile conta (Standard)

Cuprotungstite. A mineral, $CuWO_4$ WO_4+2H_2O. Its able, and it m for some min group.

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llowish to brownish
ining zirconia, yttria,
other rare earths.
pegmatites. (U. S. Geol.

D.

. A vitrophyric or felsophyric,
erally volcanic, igneous rock,
ontaining essential plagioclase and
quartz, with or without hornblende
and biotite or both; quartz andesite.
(La Forge)

Dacker (Eng.). Insufficient ventilation of a mine (Bainbridge). Dead air.

Dacker of wind (Derb.). Poor ventilation in a mine. (Hooson)

Dad (No. of Eng.). In coal mining, to mix (fire damp) with atmospheric air to such an extent that the mixture is incapable of exploding (Century). Also called Dash.

Dado (Sp.). 1. Die of a stamp mill. 2. A stone on which a horse whim (malacate) works. (Halse)

Dag (Aust.). A system whereby the earnings of members of the Coalminers' Federation are practically equalized. (Power). *Compare* Darg.

Dagger (Ark.). A T-shaped iron about 4 feet long, used to force an auger into hard coal. The point is placed in a hole dug in the floor while the miner drilling the hole presses his breast against the crossbar. The end of the auger fits into any one of a number of recesses in the stem of the dagger. (Steel)

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Cut-off entry. An entry driven to intersect another and furnish a more convenient outlet for the coal. Also called Cut-off. *See* Entry. (Steel)

Cut-out. 1. (Forest of Dean). *See* Crutt or Branch, 1. 2. (Eng.) A fault which dislocates a seam of coal more than its entire thickness. (Gresley)
3. A device for cutting out a portion of an electric circuit, generally including a fuse designed to melt when the current exceeds a certain strength. A circuit breaker. (Webster)

Cut-over (Mid.). To cut a seam of coal in a long-wall working, over or beyond the first joint or cleat. (Gresley)

Cuts (Scot.). Strips of coal worked off the sides of pillars (Gresley). Also called Slices, or Skips.

Cut shot. A shot designed to bring down coal which has been sheared or opened on one side. (Barrowman)

Cutter. 1. A term employed in speaking of any coal-cutting or rock-cutting machine; the men operating them, or the men engaged in underholing by pick or drill. (Steel)
2. (Scot.) A fissure or natural crack in strata. (Gresley)
3. A joint, usually a dip joint, running in the direction of working (Webster). Usually in the plural.
4. (Mt. Pleasant, Tenn.) An opening in limestone, enlarged from cracks as fissures, by solution, which is filled by clay and usually contains valuable quantities of brown phosphate rock. (W. C. Phalen, mineral technologist, U. S. Bur. Mines)
5. A crack in a crystal which destroys or lessens its value as a lapidary's stone. (Century)

Cutter bar. That part of a chain mining machine that supports the cutting chain and extends under the coal. (Harr)

Cuttery (Scot.). Much intersected with joints or fissures, *e. g.*, cuttery sandstone. (Barrowman)

Cut-through. 1. (No. Staff.). An opening between headings every 18 to 20 yards in mines having a steep inclination. *See also* Dip, 3 and 4. (Gresley)
2. (Aust.). A connection between bords, used for ventilation and traveling purposes. (Power)

Cutting. 1. (Eng.) The end or side of a stall next to the solid coal where the coal is cut with a pick in a vertical line to facilitate breaking down. Channeling. (Gresley)
2. The opening made by shearing or cutting. (Steel)
3. Low-grade ore or refuse obtained from dressing ore. 4. The operation of making openings across a coal seam as by channeling, or beneath a coal seam as by undercutting.

Cutting box. A box into which diamond dust falls when the diamonds which are cemented into the cutter and setter are rubbed against each other. (Century)

Cutting chain. The sprocket chain which carries the steel points used for undermining the coal with chain mining-machines. (Steel)

Cutting down. The trimming of shaft walls to increase its sectional area. (C. and M. M. P.)

Cutting shot (Ark.). A shot put in beside a cutting so as to blast some coal into it and to shatter the coal beyond for aid in making the next cutting. *See also* Shot. (Steel)

Cut-up (Scot.). An excessive roof fall leaving a large open space above. (Gresley)

Cuvelage (Fr.). Same as Tubbing.

Cuvette. 1. (Fr.) A bowl or basin of pottery or china; a flat-bottomed piece containing a water pot. 2. The vessel in which molten glass is received from the refining-pot and borne to the table for casting and rolling. (Standard)

Cuyuna. The name of an iron range in Minnesota. It is composed of the syllables, "Cuy" and "Una", the former being a contraction of the given name of Cuyler Adams who was active in the early development of that territory, and the last syllable is the name of his dog "Una".

Cwt. An abbreviation for a hundredweight, or 112 pounds avoirdupois.

Cyanamid. A trade name for a material containing about 50 per cent true cyanamide (CH_2N_2), and 25 per cent calcium hydroxide. Commercial cyanamid is made by passing nitrogen over a heated mass of calcium carbide (CaC_2) and contains 35.0 per cent nitrogen.

Cyanamide. A white crystalline compound (CH_2N_2) formed by the action of cyanogen chloride on ammonia. (Standard)

Cyanidation. 1. Conversion of gold into a double cyanide of potassium and gold by the action of cyanide of potassium (Duryee). *See* Cyanide process. 2. The act or process of cyaniding. (Webster)

Cyanide. 1. A compound of cyanogen with an element or radical. 2. To treat with cyanide (Webster). Potassium and sodium cyanides are used in the extraction of gold.

Cyanide mill. A mill in which the cyanide process is carried on. (Webster)

Cyanide process. A process for the extraction of gold from finely crushed ores, concentrates and tailings by means of cyanide of potassium used in dilute solutions. The gold is dissolved by the solution and subsequently deposited upon metallic zinc or by other means. (Skinner). *See also* McArthur and Forest process.

Cyanite; Disthene. A mineral indentical in chemical composition with andalusite and sillimanite, $Al_2O_3.SiO_2$, but differing in crystal form. Generally in flat-bladed pieces. Sometimes used as a gem. (U. S. Geol. Surv.) Also spelled Kyanite.

Cyanogen. 1. A univalent radical, CN, composed of carbon and nitrogen, present in hydrocyanic acid and the cyanides. 2. A colorless, poisonous gas, $(CN)_2$, with an odor like that of peach leaves. (Webster)

Cyanotype. A simple method of producing photographs, usually blue in color, by the use of paper, linen or the like, coated with certain compounds of cyanogen and iron. Also a print so obtained. It is used for copying maps and charts. (Webster)

Cyanuret. A former name for cyanide. (Standard)

Cyclic. Applied to any action or process that after going through a certain course, or accomplishing a definite order of changes, begins again the same course or order, and so on indefinitely until some new influence stops or changes the action. (Ransome)

Cyclic twin. Composed of parts which appear to have been alternately revolved 180° upon non-parallel twinning planes. The varieties with names are trillings, fourlings, sixlings and eightlings. (Butler)

Cylinder metal. Cast iron alloyed with two or more per cent of manganese and possessing a low coefficient of friction when highly polished. Used for engine cylinders. (Webster)

Cymogene. A product obtained by the redistillation of American petroleum (Mitzakis). Usually nearly pure butane.

Cymophane. A synonym for Cat's-eye.

Cyprine. A variety of vesuvianite or idocrase, of a blue tint, which is supposed to be due to copper. (Century)

Cyrtolite. A yellowish to brownish mineral containing zirconia, yttria, ceria, and other rare earths. Found in pegmatites. (U. S. Geol. Surv.)

D.

Dacite. A vitrophyric or felsophyric, generally volcanic, igneous rock, containing essential plagioclase and quartz, with or without hornblende and biotite or both; quartz andesite. (La Forge)

Dacker (Eng.). Insufficient ventilation of a mine (Bainbridge). Dead air.

Dacker of wind (Derb.). Poor ventilation in a mine. (Hooson)

Dad (No. of Eng.). In coal mining, to mix (fire damp) with atmospheric air to such an extent that the mixture is incapable of exploding (Century). Also called Dash.

Dado (Sp.). 1. Die of a stamp mill. 2. A stone on which a horse whim (malacate) works. (Halse)

Dag (Aust.). A system whereby the earnings of members of the Coalminers' Federation are practically equalized. (Power). *Compare* Darg.

Dagger (Ark.). A T-shaped iron about 4 feet long, used to force an auger into hard coal. The point is placed in a hole dug in the floor while the miner drilling the hole presses his breast against the crossbar. The end of the auger fits into any one of a number of recesses in the stem of the dagger. (Steel)

Dagh (Turkey). Hill; mountain. (Crofutt)

Dagner condenser. A series of muffle-shaped pipes through which distilled zinc is passed for condensation. (Ingalls, p. 551)

Dahamite. A name derived from Dahamis, a place on the island of Socotra, and given by A. Pelikan to a dike rock of brown color, compact texture with red phenocrysts of tabular albite or albite-oligoclase. The mineralogical composition as shown by recasting an analysis is albite, 43.8; anorthite, 2.8; orthoclase, 12.2; quartz, 31.5; riebeckite, 6.8. The rock appears to be a variety of paisanite. (Kemp)

Daily report. *See* Boring journal.

Dalama (Zambesi). Gold. (Lock)

Dale. 1. (Scot.) A measure by which coal was formerly sold in the east of Scotland. (Barrowman)
2. A low place between hills; a valley. (Webster)

Dalton's law (multiple proportions). If two elements *A* and *B* form several compounds with each other, and we consider any fixed mass of *A*, then the different masses of *B* which combine with the fixed mass *A* bear a simple ratio to one another (Liddell). Thus, iron and oxygen unite in the proportion FeO, Fe_2O_3 and Fe_3O_4, in which compounds (considering the oxygen) 3 and 4 are simple multiples of one.

Dam. 1. A barrier to keep foul air, or water, from mine workings (Davies). *See* Stopping; *also* Bulkhead.
2. The wall of refractory material, forming the front of the fore-hearth of a blast furnace. It is built on the inside of a supporting iron plate (dam plate). Iron is tapped through a hole in the dam, and cinder through a notch in the top of the dam. *See also* Lurmann front. (Raymond)

Dama (Sp.). A dam or stone at the end of a fire hearth of a furnace. (Halse)

Damaged-ground rent (Eng.). Usually double agricultural rent for land occupied by engines, heapstead, shops, houses, railways, etc. (G. C. Greenwell)

Damask. The etched or "watered" surface produced on polished (welded) steel, by corrosion. (Raymond)

Damourite. A hydrous muscovite. (Dana)

Damourite-schist. A schistose metamorphic rock composed largely or wholly of damourite. It comprises much of what was formerly called hydromica schist. (La Forge)

Damp. A general term for gaseous products formed in coal mines, etc., as distinguished from pure air. *See also* Afterdamp; Black damp; Choke damp; Fire damp; Stink damp; White damp.

Damped (Eng.). Suffocated by gas or foul air in a mine. (Gresley)

Damper. A valve in a flue or at the top of chimney to regulate the draft. (Raymond)

Dam plate. In a blast furnace, the cast-iron plate which supports the dam or dam stone in front (Century). *See* Dam, 2.

Damposcope (Scot.). An instrument invented by Professor Forbes, Glasgow, for detecting fire damp. (Described in Trans. Min. Inst. Scotland, vol. 1, p. 278.) (Barrowman)

Damp sheet (So. Staff.). A large sheet placed as a curtain or partition across a gate road to stop and turn an air current. (Raymond)

Dampy (Mid.). Mine air mixed with so much carbonic acid gas as to cause the lights to burn badly or to go out. (Gresley)

Dam shale. A Scottish oil shale. (Bacon)

Dam stone. The wall of fire brick or stone inclosing the front of the hearth in a blast furnace. *See also* Dam, 2. (Century)

Dan. 1. (Mid.). A tub or barrel, sometimes with and sometimes without wheels, in which mine water is conveyed along underground roadways to the sump or raised to the surface. 2. A small box or sledge for carrying coal or waste in a mine. (Gresley)

Danalite. A flesh-red to gray translucent sulpho-silicate, $(Be, Fe, Zn, Mn)_7Si_3O_{12}S$, mineral, usually massive but sometimes crystallizing in the isometric system. (Standard)

Danburite. A pale-yellow to colorless, vitreous, translucent to transparent, calcium boro-silicate mineral, $CaB_2(SiO_4)_2$, crystallizing in the orthorhombic system. (Dana)

Dander (Scot.). A piece of slag, vitrified refuse, or calcined cinder. (Webster)

Dandered coal (Scot.). Coal burned by, and generally mixed with trap rock (Barrowman). *See also* Natural coke.

Danforth's oil. *See* Naptha.

Danger board (Scot.). A board on which notice is given, warning against entering a dangerous part of the mine workings (Barrowman). *See also* Fire board.

Danger signal. A signal consisting of a board, shovel, or other material with appropriate markings thereon, placed in the front of a room or entry containing an explosive mixture of fire damp. (Roy). *Also*, a placard to indicate the location of dangerous machinery, electric wires, explosives, mine openings, etc.

Danks. Black shale mingled with fine coal. (Standard)

Danks' puddler. A revolving mechanical puddler. *See also* Puddling. (Raymond)

Dant. 1. (Newc.) Soft, inferior coal; mineral charcoal. (Raymond)
2. To reduce, as a metal, to a lower temperature. (Standard)

Danty (No. of Eng.). Disintegrated coal. (Gresley)

Dap. A notch cut in a timber to receive another timber. (C. M. P.)

Darapskite. A hydrous sodium nitrate and sulphate mineral, $NaNO_3.Na_2SO_4.+H_2O$. (Dana)

Dar cuele (Mex.). To drive a level. (Dwight)

Darg. 1. (No. of Eng.) A specified quantity or weight of mineral agreed by the managers and men to be produced during a shift for a certain sum of money. (Gresley)
2. (Scot.) To work by the day.
3. A days' labor; toil. 4. *See* Dag.

Darger (Scot.). One who works by the day. (Standard)

Dark ruby silver. *See* Pyrargyrite.

Darrlinge (Ger.). Residue of copper resulting from the process of separating silver from copper by liquation. (Whitney)

Dash (No. of Eng.). *See* Dad.

Dashing (Eng.). Increasing the amount of air in mines to prevent explosions of mine gases. (Bainbridge). *See also* Dad.

Dash pot. 1. A device for cushioning or damping a movement to avoid shock, consisting essentially of a cylinder containing air or a liquid and a piston moving in it. 2. A device for closing the valves on a Corliss engine, actuated by atmospheric pressure or a spring. (Webster)

Dass. 1. (Scot.). A slice or cut taken off a pillar in stoping. (Barrowman)
2. A stratum. 3. To work in or cut out layers from the face of a cliff. A variation of Dess. (Webster)

Datalling (Eng.). Blowing (blasting) down roof in a mine. (Gresley)

Datlers (Lanc.). Men who work underground, and are paid by the day; not contractors. (Gresley)

Datolite. A hydrous silicate of boron and calcium, $H_2O.2CaO.B_2O_3.2SiO_2$. The mineral is used as a gem. (U. S. Geol. Surv.)

Datolite group. A group of minerals, the species of which are usually regarded as orthosilicates, $HR'R''SiO_5$, or $R'_2R''_2(SiO_4)_2$; R'= Ca, Be, Fe, chiefly; R''=Boron, the yttrium (and cerium) metals, etc. All of the minerals of this group crystallize in the monoclynic system. (Dana)

Datum. 1. Any position or element in relation to which others are determined, as datum point; datum line; datum plane. 2. The mean low-water mark of all tides, assumed as a base of reckoning. (Webster)

Datum level. The level (usually sea level or mean level of nearest considerable body of water) from which altitudes are measured in surveys. (Weed)

Datum water level. The level at which water is first struck in a shaft. (C. and M. M. P.)

Daugh (Scot.). Soft fire clay associated with a seam of coal, and in which the holing is usually made. (Barrowman)

Dauk; Dawk; Douk (Eng.). Tough; compact; sandy clay. (Power)

Davis furnace. A long, one-hearth reverberatory furnace, heated by lateral fireplaces for roasting sulphide ore. (Ingalls, p. 97)

Davy; Davy lamp. A safety lamp invented by Sir Humphrey Davy in 1815 for the protection of coal miners. Its safety feature consisted of a fine-wire gauze inclosing the flame to keep it from coming in contact with mine gas.

Davy man (Newc.). The man who trims and repairs the Davy lamps. (Min. Jour.)

Dawling (Derb.). A failing ore body, both in quality and quantity. (Hooson)

Dawsonite. A basic carbonate of aluminium and sodium, $Na_2Al(CO_3)_2 \cdot 2Al(OH)_3$, mineral occurring in thin incrustations of white radiating bladed crystals. (Dana)

Dawson producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 305)

Day. 1. A term used to signify the surface; thus, "driven to day," meaning to daylight, therefore to the surface. (Chance)
2. (Wales) The surface of the ground over a mine. Day level,—An adit. Day water—Water from the surface. (Raymond)
3. (Derb.) Ore that is found near the surface. (Mander)

Day-coal. The upper stratum of coal; as nearest the light or surface. (Webster)

Day drift. A drift with one end at the surface (Webster). An adit.

Day eyes (Wales). Inclined planes driven from the surface to the coal bed. (Gresley)

Day fall. *See also* Crop fall.

Day hole. Any heading or level in a mine communicating with the surface. (Century)

Day level (Scot.). A level driven from the surface (Barrowman). An adit.

Daylight mine (Scot.). A mine or drift extending to the surface. (Barrowman)

Day man. A coal mine employee paid by the day as distinguished from those paid by the piece, or by contract. Also called Company man. (Steel)

Day pair (Corn.). Miners who work underground during the day (Pryce). The day shift.

Day shift. A group of miners, or other laborers, who work during the day.

Day stone (Eng.). A rock lying exposed in its natural state. (Webster)

Day water. Surface water. (Webster)

Daywork. All work other than that done by the piece or contract, such as repairing roads, handling cars, etc. Also called Company work and does not include work for which the men are paid by the month (Steel). Work performed by day men.

Dead. 1. (Corn.) Unventilated. 2. As to a vein or piece of ground, unproductive. (Raymond)
3. (Eng.). The creep, after subsidence or upheaval has taken place to the full extent. (Gresley)

Dead air. The air of a mine when it contains carbonic-acid gas (black damp), or when ventilation is sluggish. (Stewart)

Dead coal (Kansas). A noncoking coal mined from strip pits and used for zinc smelting. (Stewart)

Dead-dipping. The act or process of imparting a dead, or dull, surface to brass or other metal by dipping it in an acid. (Webster)

Dead end. An entry, gangway, level, or other mine passage extending beyond the mine workings into solid coal or ore; a stub. *See* Stub entry.

Dead end (of a pipe). The closed end of a pipe or system of pipes. (Nat. Tube Co.)

Deadened mercury. *See* Floured.

Deadfall. A dumping platform at the mouth of a mine. (Standard)

Dead glacier. A stagnant glacier; a fossil glacier. (Century)

Dead ground. 1. Rock in a mine, which, although producing no ore, requires to be removed in order to get at productive ground. (Roy. Com.)
2. A faulty or barren area of coal strata. (Gresley)

Deadhead. 1. An extra length given to a cast object, as a cannon, to put pressure on the molten metal below so that dross and gases may rise into it; a sullage piece; a sinking-head. 2. That part of a casting filling up the ingate; a sprue. (Standard)

Dead hole. A shallow hole in an iron casting. (Standard)

Deading (Glouc., Som.). Same as Deadwork.

Dead-line. A row of marked empty powder kegs or other danger signal placed by the fire boss to warn miners not to enter workings containing gas. (Steel)

Dead lode. A lode not containing valuable minerals in paying quantity.

Deadman. 1. A buried log, or the like, serving as an anchor, as for a guy rope. (Webster)
2. A wooden block used to guard the mouth of a mine against runaway cars. (Connors-Weyman Steel Co. *v.* Kilgore, 66 Southern, p. 612)

Dead mens' graves (Aust.). Grave-like mounds in the basalt underlying auriferous gravels. (C. and M. M. P.)

Dead oil. A name given to those products of distillation consisting of carbolic acid, naphthalin, etc., obtained in the distillation of coal tar, which are heavier than water and which come off at about 340° F., or over. (Century)

Dead-plate. A nearly horizontal iron plate, at the mouth of the furnace, under a steam boiler, on which the bituminous coal charges are laid to be partly coked before they are pushed upon the grate where their solid carbon is consumed. The gases evolved on the dead-plate pass over the grate and are burned. (Raymond)

Dead quartz. Quartz carrying no valuable mineral. (Ihlseng)

Dead rent. A certain, fixed, or minimum rent paid at specified times by a lessee, whether the mine is worked or not. (Vandalia Coal Co. *v.* Underwood, 111 N. E. Rept., p. 330; New York Coal Co. *v.* New Pittsburgh Coal Co., 99 N. E. Rept., 198)

Dead riches. Base bullion. (Miller)

Dead roast. Roasting carried to the farthest practicable degree in the expulsion of sulphur. (Raymond)

Dead rock. The material removed in the opening of a mine, that is of no value for milling purposes. Waste rock. (Duryee)

Dead rope (Aust.). Same as **Buffer rope.**

Deads. 1. (Corn.) The waste rock, packed in excavations from which ore or coal has been extracted. (Raymond)
2. The barren rock which incloses the ore on every side. The wall rock.

Dead small (No. of Eng.). The smallest coal which passes through the screening or separating apparatus. (Greeley)

Dead-stroke hammer. A power hammer striking an uncushioned or inelastic blow. (Standard)

Dead water. Standing or still water. (Webster)

Dead weight. The unrelieved weight of anything inert. A heavy or oppressive burden. (Webster)

Deadwork. Work that is not directly productive, though it may be necessary for exploration and future production (Raymond). Unfinished work.

Deaf ore. (Derb.). Gouge containing small grains of valuable mineral. Considered as indicating that the main orebody is not far away. (Hooson)

Deal. 1. Plank used in shaft and gallery construction. (Raymond)
2. A board or plank of varying dimensions. In Canada it is a board 12 feet long, 11 inches wide and 2½ inches thick; in England, a board not exceeding 3 inches thick and 9 inches wide. (Standard)

Deal-end (Eng.). A plank less than 6 feet long. (Standard)

Dean (Corn.). The end of a level. (Raymond)

Debacle. 1. A great rush of waters, which, breaking down all opposing barriers, carries forward the broken fragments of rocks, and spreads them in its course. (Comstock)
2. The breaking up of ice in a stream. A violent dispersion or disruption. (Webster)

De Bavay process. A flotation process invented by Auguste J. F. De Bavay in 1904, in which a freely flowing pulp is brought to the surface of a vessel of water, where advantage is taken of the surface tension of the liquid, and the sulphide floated. A film of carbonate on the sulphide, from weathering, is detrimental, and is removed by soaking the ore in a weak solution of carbonate of ammonia, or by passing carbon dioxide through the pulverized wet ore, or by friction. In the original process no oil or acid was used. Later these were also used. (Liddell)

Débil (Mex.). Weak; a term applied to amalgam when very fluid. (Egleston)

Débris. Rock fragments, sand, earth, and sometimes organic matter, in a heterogeneous mass, as at the foot

of a cliff. 2. The silt, sand, and gravel that flow from hydraulic mines; called in miner's parlance, tailings, slums, and sometimes slickens. *See also* Tailings. (Hanks. *Also* U. S. Min. Stat., p. 940)

Débris deposits. Refuse from hydraulic mining operations. (U. S. Min. Stat., p. 933–945)

Decantation. The act of pouring off a liquid so as not to disturb a sediment or precipitate. (Webster)

Decanter. 1. A vessel used to decant liquors, or for receiving decanted liquors, as in a laboratory. (Webster)
2. An apparatus for sorting and classifying tailings from gold-washing operations.

Deck. The platform of a cage upon which the cars and men ride. Cages are occasionally made with two, three, or four decks. (Gresley)

Decken structure. A series of great overthrust folds with nearly parallel and horizontal axial planes. (Lieth, p. 117)

Decking. The operation of changing the tubs on a cage at top and bottom of a shaft. Caging. (Gresley)

Deck molding. Trimming made to match cresting or ridging, on clay-tiled roofs, and used for the purpose of covering the planes of a roof which has a flat deck. (Ries)

Declaratory statement. In practical mining operations, a term applied to the statutory certificate of location and is a notice or statement of the location, containing a description of the mining claim, verified by the oath of the locator, performing, when recorded, a permanent function, and is the beginning of the locator's paper title, is the first muniment of such title and is constructive notice to all the world of its contents. (Gird *v.* California Oil Co., 60 Fed. Rept., p. 536; Peters *v.* Tonopah Min. Co., 120 Fed. Rept., p. 589; Magruder *v.* Oregon, etc., R. Co., 28 Land Decisions, p. 177; Pollard *v.* Shively, 5 Colorado, p. 312; Metcalf *v.* Prescott, 10 Montana, p. 284)

Declared selling price (Aust.). The nominal selling price of coal declared by the mine owners in the Newcastle district, N. S. W., every September, on which the payment to miners is based. (Power)

Declination. The angle which the magnetic needle makes with the geographical meridian. It is said to be east or west, according as the north end of the needle points to the east or west of the geographical meridian.

Declinometer. An instrument, often self-registering, for measuring or recording the declination of the magnetic needle. (Standard)

Decompose. To separate the constituent parts of; to resolve into the original elements; to rot or decay. (Webster)

Decomposing furnace. A furnace used in the conversion of common salt into sulphate of soda, aided by the action of sulphuric acid. (Century)

Decomposition. The breaking up or decay of compounds into simpler chemical forms. (Roy. Com.)

Decrepitate. To roast or calcine so as to cause crackling; to crackle, as salt, from the presence of moisture, when heated. (Webster)

Decrepitation. The breaking up with a crackling noise of mineral substances when exposed to heat, as when common salt is thrown upon the fire. (Roy. Com.)

Deeds (No. of Eng.). Débris or waste thrown upon the spoil bank (dump). (Gresley). A variation of Deads.

Deep. 1. (Corn.) The lower portion of a vein; used in the phrase "to the deep," *i. e.*, downward upon the vein. (Raymond)
2. Workings below the level of the pit bottom or main levels extending therefrom. 3. (Forest of Dean; Lanc.) A vein, seam, mine, or bed of coal or ironstone. (Gresley)

Deep coal (Eng.). Coal seams lying at a depth of 1,800 feet or more below the surface. (Gresley)

Deep leads. Alluvial deposits of gold or tinstone buried below a considerable thickness of soil or rock. (Duryee)

Deep-level (Trans.). In South Africa, the first mining properties developed from the surface were estopped from trespassing beyond their side lines projected downward. The next mine on the dip of the lode became known as the "deep-level" mine or "deep." *Jour.*, Chem., Met. and Min. Soc., So. Africa, vol. 14, 1914, p. 361)

Deep pit (Eng.). A shaft exceeding 400 or 500 yards in depth. (Gresley)

Deep-sinker (Aust.). A tall drinking glass; also the drink it contains, so called in fanciful allusion to the shaft of a mine. (Webster)

Deep-well pump. A pump for oil wells, etc. (Standard)

Deficient coal (Ark.) Coal more difficult to mine than the standard, and for which the miners are paid an extra price. (Steel)

Deficient place (Aust.). A working place in which men cannot make fair average wages, and for which they are given extra pay. (Power)

Definite proportions law. One of the fundamental chemical laws that a chemical compound always contains the same elements in the same proportions by weight (Liddell). *Compare* Dalton's law.

Deflagrate. To burn; burst into flame; specifically to burn rapidly, with a sudden evolution of flame and vapor, as a mixture of charcoal and niter thrown into a red-hot crucible. (Century)

Deflagrating mixture. Combustible mixtures generally made with niter, the oxygen of which is the active ingredient in promoting their combustion. (Century)

Deflagration globe. A large glass globe for deflagration experiments, as burning phosphorous in oxygen. (Webster)

Deflagration spoon. A spoon with a long vertical handle, used in deflagration experiments. (Webster)

Deflation. The removal of loose material by the wind, leaving the rocks bare to the continuous attack of the weather. (Webster)

Deflection angle. In railroad surveying, the angle formed at any point of a curve between the tangent and a chord of 100 feet, and is, therefore, one half the degree of curve.

Deflocculating agent. An agent which produces deflocculation, as for example the alkalis in certain concentration, and which therefore hinders settling. (Eng. and Min. Jour., vol. 101, p. 431)

Deflocculation. A relative term opposed to flocculation, *which see.*

Deformation of rocks. 1. Restrictedly, distortion of rock masses by pressure, evidenced by foliation, mutual indentation of pebbles in conglomerate, distortion of fossils, stylolites, etc. (Standard)
2. Any change in the original shape of rock masses. Folding and faulting are common modes of deformation. (Ransome)

Degradation. The general lowering of the surface of the land by erosive processes, especially by the removal of material through erosion and transportation by flowing water. (La Forge)

Degrade. To wear down by erosion. (Webster)

Degree. A division, space, or interval marked on a mathematical or other instrument, as on a thermometer. (Webster)

Degree of curve. In railroad surveying, that angle subtended, at the center of curvature, by a chord of 100 feet. It is twice the deflection angle.

Dehne filter press. A standard plate-and-frame filter press. (Liddell)

Dehydrate. To render free from water. (Webster)

Deil (Scot.). A tool for unscrewing broken rods in a bore hole. (Barrowman)

Deister table. A riffled table used in ore dressing in which the angle between the line of termination of the riffles and the direction of motion is not so acute as in the Wilfley. It is also wider and shorter. The top is rhomboidal. (Liddell)

Dejar respaldado (Peru). To leave valuable ore in the wall-rock. (Dwight)

Delay electric blasting-cap. A detonating device with a delay element between the priming and detonating composition. It detonates about one or two seconds after the electric current has passed through the bridge. They are made in two kinds—first and second delay—and are used in connection with regular, waterproof or submarine electric blasting-caps for blasting in tunnels, shafts, etc., where it is desirable to have charges fired in succession without the necessity of the blaster returning between shots. (Du Pont)

Delay electric-igniter. An electrical device using fuse as the delay element by which it is possible with the use of a blasting cap on each fuse to detonate a number of charges in succession. (Du Pont)

Delessite. A chloritic mineral of scaly or short fibrous appearance filling cavities or seams in basic igneous rocks. (Dana)

Delf. 1. (Forest of Dean, Lanc.) A vein, seam, or bed of coal or ironstone. (Gresley)
2. (Eng. and Scot.) A thing which has been dug; a mine; a quarry; a pit. (Webster)

Delfman (Eng.). A miner or workman in a stone quarry. (Webster)

Deliquescent. Capable of becoming liquid by the absorption of water from the air. (Standard)

Delivery drift (Eng.). A drift or adit driven from low ground into the shaft to receive water pumped from a lower level. Also called Off-take drift. (G. C. Greenwell)

Dellenite. A name proposed by Brögger for an intermediate group of effusive rocks, between the dacites and the liparites (rhyolites). The name is derived from Dellen, Helsingland, Sweden. *Compare* Toscanite. (Kemp)

Delprat method. *See* Overhand stoping.

Delprat process. *See* Potter-Delprat process.

Delta. An alluvial deposit at the mouth of a river (Webster). Usually more or less triangular in form.

Deltafication. The process of forming a delta at the mouth of a river. (Century)

Deltaic. 1. Pertaining to or like a delta. 2. Having or forming a delta. (Century)

Deltaic deposits. Sedimentary deposits laid down in a river delta. (Ransome)

Delta-metal. A non-rusting, copper, zinc, and iron alloy resembling Aich's-metal and sterro-metal. (Standard)

Deltoid dodecahedron. An isometric form of 12 faces, each a quadrilateral, distributed as determined by the tetrahedral type of symmetry (Dana). Sometimes called Deltohedron.

Dema (Sp.). 1. Timbers; lagging. 2. A dry-stone wall. 3. (Colom.). The side of a ground sluice. (Halse)

Demagnetize. To deprive of magnetic polarity. (Century)

Demar (Sp. Am.). To timber; to construct the sides of channels and sluices. (Lucas)

Demasía (Mex.). Unoccupied ground between two mining concessions, less than one *pertenencia* in extent. (Dwight)

Demenge process. A process of hardening the face of a steel ingot by carburizing one side in the casting mold. (Standard)

Demurrage. A charge for the detention of railway cars over a certain period allowed for loading or unloading.

Dendriform. Resembling a tree; arborescent; dentritic (Century). Said of certain minerals.

Dendrite. 1. A branching figure resembling a shrub or tree, produced on or in a mineral or rock by the crystallization of a foreign mineral, usually an oxide of manganese, as in the moss agate; also the mineral or rock so marked.
2. A crystallized arborescent form, as of gold or silver; an arborization. (Webster)

Dendritic. Branching like a tree; said of minerals, as crystallized gold.

Dendroid. Dentritic; arborescent.

Denounce (Mex.). To offer for record, legal notice of a claim for a mining concession, covering a described area, the mining rights of which are held by the government (Webster). *See also* Denuncia.

Densimeter. An apparatus for determining the specific gravity or relative density of a substance. (Standard)

Density. 1. The ratio of the mass of any volume of a substance to the mass of an equal volume of some standard substance. For liquids and solids the standard substance is water. (Webster)
2. The quality of being dense, close, or compact. 3. The quantity of electricity per unit of volume at a point in space, or the quantity of electricity per unit of area at a point on a surface. (Century)

Denudación (Sp.). Denudation or erosion. (Halse)

Denudation. 1. The washing down of surface deposits so as to lay bare underlying formations. This washing away in one place is associated with the idea of deposition in another. (Roy. Com.)
2. In geology, the same as erosion, although there has been an effort by some to restrict the term to the stripping away of overlying material from some particular rock or surface. (Ransome)

Denude. To wear away or remove overlying matter from and so expose to view, as underlying rocks. (Standard)

Denuded. In geology, rocks exposed by the action of denudation. (Century)

Denuncia (Sp.). 1. In Mexico and Spanish America, the judicial proceedings by which a person claims and secures the right to a mine which he has discovered, or one the *title to* which has been lost or forfeited by the neglect of the owner to work it, or by his having violated the mining ordinances. 2. A similar judicial proceeding by which waste or abandoned lands may be preëmpted. (Century)

Denunciador (Mex.). The denouncer of a mine. (Halse)

Denunciamiento (Sp.). In mining, the act of giving formal notice of a claim; also, the claim itself. (Standard)

Denunciante (Colom.). The denouncer of a mine or claim; a claimant. (Halse)

Denunciar (Sp.). To denounce. To give information that a mine is forfeited for being insufficiently worked, or for a violation of some condition which imposes that penalty. This term is also applied to the giving notice of a discovery, for the purpose of registry. (Raymond)

Denuncio (Mex.). Denouncement; the act of applying for a mining concession under the old mining laws. (Dwight)

Departamento (Sp.). Department; a province, district or subdivision of a country. (Halse)

Dependiente (Mex.). An inferior officer or clerk. (Halse)

Dephlegmator, or separator. An instrument used in the refining of petroleum to arrest the oil mechanically carried over by the vapor. (Mitzakis)

Depletion. The act of emptying, reducing or exhausting, as the depletion of natural resources (Century). In mining, specifically said of ore reserves.

Deposit. 1. Anything laid down. Formerly applied to (suspended) matter left by the agency of water, but now made to include also mineral matter in any form, and precipitated by chemical or other agencies, as the ores, etc., in veins. (Winchell)
2. The term mineral deposit or ore deposit, is arbitrarily used to designate a natural occurrence of a useful mineral or ore in sufficient extent and degree of concentration to invite exploitation. (Raymond)

Deposition. 1. The process of natural accumulation of rock material, as when thrown down or collected in strata by water, wind, or volcanic action: also material thus deposited. Opposed to denudation. (Standard)
2. The precipitation of mineral matter from solution, as the *deposition* of gate, vein quartz, etc.

Depósito (Sp.). 1. A deposit, generally sedimentary; a synonym of *yacimiento; D. de metal*, an ore deposit; *D. de minerales*, a mineral deposit. 2. Cistern or tank. 3. (Mex.) An ore bin. 4. *Depositos* (Mex.). water collected in old workings. (Halse)

Depp (Derb.). The continuance of ore with depth. (Mander)

Depreciation. The loss in the value of physical property due to use, or otherwise, which cannot be made good by current repairs. (E. B. Skinner, p. 149)

Depreciation fund. A fund set aside to replace a piece of depreciable property when it is worn out. (E. B. Skinner, p. 150)

Depression. 1. A lowering, sinking or diminution. 2. The angular distance of an object beneath the horizontal plane that passes through the observer. Used in surveying. (Webster)

Deputy. 1. (No. of Eng.) A man who fixes and withdraws the timber supporting the roof of a mine, and who attends to the safety of the roof and sides, builds stopping, puts up bractticing, and looks after the safety of the miners. 2. (Mid.) An underground official who looks after general safety of a certain number of stalls (rooms) or of a district, but who does not set the timber himself

although he has to see that it is properly done. (Gresley)
3. A mine boss. (Roy)

Deputy overman (Newc.). The man who lays the plates and sets the timber for the miners, and has charge of a portion of the mine. (Min. Jour.)

Deputy surveyor; Mineral surveyor. A person appointed by the Surveyor General of the United States to make proper surveys of lode or placer mining claims, prior to the issuing of a patent. (U. S. Min. Stat., p. 577–581)

Deputy system (No. of Eng.). The plan of having all the timbering in working places performed by specially appointed deputies (Gresley). *See also* Deputy.

Derbylite. A mineral, composed of antimonate and titanate of iron, occurring in black orthorhombic crystals. (Dana)

Derbyshire spar; Derby spar. Fluorite, found abundantly in Derbyshire, Eng. (Chester). Fluorspar.

Derecho (Sp.). 1. Law; equity. 2. *Derechos;* taxes; dues; customs. (Halse)

Derivative rocks. Rocks derived by erosion or comminution from existent rocks or rock material, as a sedimentary rock and volcanic tufa. (Standard)

Derrame de veta (Sp.). Fragments of ore scattered over the surface of the country near the lode. (Lucas)

Derribar Sp.). To break ground. (Halse)

Derrick. 1. The framework or tower over a deep drill hole, such as that of an oil well, for supporting the tackle for boring, hoisting or lowering. 2. Any of various hoisting apparatus employing a tackle rigged at the end of a spar or beam. (Webster)
3. (Corn.) A digger; a miner. (Pryce)

Derrick car. A wrecking car fitted with a derrick or crane. (Webster)

Derrick crane. A crane in which the top of the post is supported by fixed stays in the rear and the jib is pivoted like the boom of a derrick. (Century)

Derricking. Operating like a derrick, as regards the raising and lowering of the jib. (Webster)

Derrocado (Mex.). A mine in which the workings have caved. (Halse)

Derrumbe. 1. (Colom.) A land slip. 2. (Peru) A small and narrow mountain pass. (Halse)

Desaguador (Sp.). A water pipe; drain. (Dwight)

Desaguar (Sp.). To drain; to pump; to unwater. (Lucas)

Desagüe (Mex.). Unwatering; mine drainage. (Dwight)

Desamparar (Sp.). To abandon, as a mine. (Halse)

Desanchar. 1. (Sp.). To undercut. 2. *D. la veta* (Mex.), to take down the soft wall of a vein and leave the lode for subsequent extraction. To gouge. (Halse)

Desaplomar (Peru). In the *patio* process, to restore mercury. (Halse)

Desarenar (Colom.). To clear away the poor sand, as in placer mining. (Lucas)

Desativar (Sp.). To free a mine from rubbish or waste. (Vel.)

Desazogadera (Sp. Am.). A receptacle for the condensed quicksilver resulting from the roasting operation. (Halse)

Desbocarse el barreno (Peru). To remain (as a drill hole) practically intact after firing. (Dwight)

Desbordar (Mex.). 1. To stope underhand. 2. To rob mine pillars. (Dwight)

Desborde (Mex.). An underhand stope. (Dwight)

Descapotar (Sp. Am.). To clear away a capping. (Lucas)

Descargadora (Mex.). A discharging tank, from which the slimes are run off last. (Egleston)

Descargar (Sp.). 1. Literally, to unload; *D. un horno*, to tear down a furnace. (Dwight)
2. (Colom.) To take away stones in order to facilitate the washing of gold-bearing sands. (Halse)

Descargue (Mex.). The last ingot reduced in a smelting furnace. (Rrockwell)

Descension-theory. The theory that the material in veins entered from above. (Raymond)

Descloizite. A vanadate of lead and zinc, found only in the oxidized parts of veins. (U. S. Geol. Surv.)

Descogollar (Colom.). To take away the upper part of a vein. (Halse)

Descostradores (Sp.). Men employed in taking down any fragment which may remain after blasting. (Min. Jour.)

Descriptive mineralogy. That branch of mineralogy devoted to the description of the physical and chemical properties of minerals. (Century)

Descubridora (Mex.). Discovery-mine; first mine in a district, or on a mineral deposit. (Dwight)

Descubrir (Sp.). To discover, as mines. (Halse)

Desecho (Mex.). 1. The loss of mercury through chemical reactions during amalgamation. 2. Lead-dross. 3. Assay waste. (Dwight) 4. Very low-grade or poor ores. 5. Rubbish from mines; waste rock. (Halse)

Desencielar (Colom.). To work the lode between two adits. (Lucas)

Desengranar (Mex.). To throw out of gear. (Dwight)

Desenlodar (Sp.). To separate clay from any mineral or ore. (Halse)

Desert rat (West. U. S.). A prospector, especially one who works and lives in the desert, or who has spent much time in arid regions. The name is derived from a small rodent common throughout much of the Great Basin and Southwestern United States.

Desguachar (Sp. Am.). To get out the fine gravel or dirt. (Lucas)

Desiccate. To dry up; to deprive or exhaust of moisture; to preserve by drying. (Webster)

Desiccator. A short glass jar fitted with an air-tight cover and containing some desiccating substance as calcium chloride, above which is placed the material to be dried, or preserved from moisture. (Webster)

Desierto (Mex.). Desert. (Dwight)

Desiliconize. To free from silicon or any of its compounds. (Century)

Desilverization. The process of separating silver from its alloys. (Raymond)

Desilverizing kettle. A circular kettle 3 to 4 feet deep used for the desilverization of base bullion. (Hofman, p. 451)

Desistimiento (Mex.). The abandonment of a mining claim. (Dwight)

Deslave (Sp. Am.). Tailings. (Lucas)

Deslizarse el azoque (Peru). The flouring of mercury. (Dwight)

Desmenuzable (Sp.). Friable ore. (Halse)

Desmine. *See* Stilbite.

Desmontar (Colom.). To remove overburden; to strip. (Halse)

Desmonte (Colom.). The superficial layer above the auriferous gravel. (Halse)

Desmontes (Mex.). Poor ores. (Dwight)

Desmoronos (Colom.). Surface damage caused by mine workings, for which the operator has to pay damages. (Halse)

Desmorro (Mex.). Furnace barrings. (Dwight)

Desmosite. A banded contact rock developed from shales and slates by intrusions of diabase. *Compare* Spilosite and Adinole. (Kemp)

Desnivel (Mex.). Difference in a level. (Dwight)

Despachardores (Mex.). Men employed in filling *mantas* with ore. (Halse)

Despacho (Mex.). 1. An office. 2. A commission, warrant, or patent. (Halse)

Despajar (Mex.). To remove waste rock by concentration. (Dwight)

Despaje (Mex.). Waste from a concentration plant. (Dwight)

Despensa (Mex.). 1. A storeroom for provisions. 2. A well-secured room for keeping rich ore. (Halse)

Desperdicios (Sp.). Tailings. (Lucas)

Despilado (Sp.). 1. The removing of pillars. (Halse)

Despilar; Despilarar (Mex.). To rob a mine; to remove pillars. (Halse)

Desplatar (Sp.). To desilverize. (Lucas)

Despoblado (Mex.). Ore with much gangue. (Dwight)

Despoblar (Mex.). To suspend mining work. (Dwight)

Despueble (Sp.). Abandoning the mine, or failure to keep the proper number of men at work. (Min. Jour.)

Desquinchar (Peru). To take down the walls of a lode (Halse). *See* Ensanchar, 2.

Destajero (Mex.). A contractor for piecework. (Dwight)

Destajo. 1. (Mex.) A contract; piecework as distinguished from timework. (Dwight)
2. (Peru) An open cut. (Halse)

Destrancar (Colom.). To remove obstacles which prevent the unwatering of mines. (Halse)

Destructional. Pertaining to destruction or shaped by destructive forces, as in geology, a plain which has been formed by erosion. (Standard)

Destructive distillation. The process of heating an organic compound in a closed vessel, without access of air, and collecting the products (Nicholls). A process of distillation in which hydrocarbon molecules are broken down. Thus illuminating gas is a product of the destructive distillation of coal. Also called Dry distillation, and Cracking.

Desuing (Corn.). *See* Dissuing.

Desulphurization. The removal of sulphur from sulphide ores. (Raymond)

Desulphurize. To free from sulphur; to remove the sulphur from an ore or mineral by some suitable process, as by roasting. (Century)

Desvolcanarse (Colom.). To be covered by a landslide; to be destroyed or demolished. (Halse)

Detaching hook. A self-acting mechanical contrivance for setting free a winding rope from a cage when the latter is raised beyond a certain point in the headgear; the rope being released, the cage remains suspended in the frame. (Steel)

Determinative mineralogy. That branch of mineralogy which comprises the determination of the nature, composition, and classification of minerals, by means of physical tests, blowpipe or wet analyses, and the examination of the crystallographic and the optic properties. (La Forge)

Detonador (Sp.). Fulminating cap; detonator. (Lucas)

Detonate. 1. To cause to explode with a sudden loud report. 2. To explode suddenly with a loud report. (Standard)

Detonating fuse. A fuse consisting of high explosive that fires the charge without the assistance of any other detonator. (Bowles)

Detonating gas. A mixture of two volumes of hydrogen and one volume of oxygen which explodes with a loud report upon ignition. (Webster)

Detonating powder. Any powder or solid substance, which when heated or struck explodes with violence and a loud report. (Webster)

Detonating primer. A primer exploded by a fuse, used to fire high explosives. (Webster)

Detonation. The very sudden change of unstable substances from a solid or liquid to the gaseous state with the evolution of great heat and accompanied by a sudden report.

Detonator. A term used to include blasting caps, or any device used for detonating a high explosive (Du Pont). An exploder, percussion cap, or primer.

Detonator tube. A eudiometer fitted for making explosions. (Webster)

Detrital rock. A rock made up of the débris of other rock. (Century)

Detritus. A general name for incoherent sediments, produced by the wear and tear of rocks through the various geological agencies. The name is from the Latin for "Worn." Rock waste. (Kemp)

Deuterogenic. Formed from protogenic rocks. (Standard)

Development. 1. A geological term, applied to those progressive changes in fossil genera, and species, which have followed one another during the deposition of the strata of the earth. (Roberts)
2. Work done in a mine to open up ore bodies, as sinking shafts and driving levels, etc. (Skinner). Sometimes used synonomously with "annual assessment" work.

Devil (Aust.). An automatic arrangement for detaching a set of skips from the main-and-tail rope haulage system. (Power)

Devil's dice. Cubes of limonite, pseudomorph after pyrite. (Power)

Devitrification. The process by which glassy rocks break up into definite minerals. The latter are usually excessively minute but are chiefly quartz and feldspar (Kemp). The change from a glassy to a crystaline state after solidification.

Devonian. In the ordinarily accepted classification, the fourth in order of age of the periods comprised in the Paleozoic era, following the Silurian and succeeded by the Carboniferous. Also the system of strata deposited at that time (La Forge). Sometimes called the Age of fishes.

Dewar-Redwood process. A method for cracking petroleum (1899) by the use of a suitable still and a condenser in free communication with each other, *i. e.*, without any valve between them, the space in the still and condenser not occupied with liquid being charged with air, carbonic acid gas, or other gas, under the required pressure and the condenser being provided with a regulated outlet for the condensed liquid. A full description of the process is contained in Sir Boverton Redwood's standard work on petroleum. (Mitzakis)

Dewylite. An amorphous, resinous, whitish to brown, hydrous magnesian silicate mineral, near serpentine, but with more water; formula perhaps, $4MgO.3SiO_2.6H_2O$. (Dana)

Dezuing. *See* Zur, *also* Dissuing.

Diabantite. A chloritic mineral found filling cavities in basic eruptive rocks, like basalt and diabase. (Century)

Diabasa (Mex.). Diabase. (Dwight)

Diabase. A basic igneous rock usually occurring in dikes or intrusive sheets, and composed essentially of plagioclase feldspar and augite with small quantities of magnetite and apatite. The plagioclase forms lath-shaped crystals lying in all directions among the dark irregular augite grains, giving rise to the peculiar diabasic or ophitic texture, which is a distinctive feature in the coarser-grained occurrences (U. S. Geol. Surv.)
Diabase is often used as a prefix for double names, as diabase-aphanite, diabase-gabbro, etc. (Kemp)

Diabase-porphyrite. A porphyrite whose groundmass is finely crystalline diabase, and whose phenocrysts are prevailingly plagioclase. It is contrasted with augite-porphyrite, whose phenocrysts are prevailingly augite. (Kemp)

Diablo (Mex.). 1. Rail-bender. 2. Kind of barrow used for moving heavy weights. (Dwight)
3. (Colom.) A lifting jack or screw. (Halse)

Diaclase. In geology, a line of rectangular fracture; a term applied by Daubrée to explain the fact that the lines of weakness in the earth's surface are perpendicular to one another. (Standard)

Diaclinal. Crossing a fold, as a diaclinal river. (Webster)

Diadochite. A hydrated ferric phosphate and sulphate mineral, brown or yellowish in color. (Dana)

Diagenesis. Recombination or rearrangement, resulting in a new product, as in the formation of larger crystalline grains from smaller ones. (Webster)

Diagonal joints. Joints diagonal to the direction of cleavage. (C. and M. M. P.)

Diagonal staple (No. of Eng.). A shallow pit sunk in a sloping or diagonal direction at the back of the main beam of a pumping engine and in which the lever beam works. (Gresley)

Diagonal stratification. Same as False bedding. Current bedding, and *also* Cross-bedding.

Diagram factor. A numerical coefficient by which the area of a theoretical indicator diagram must be multiplied to approximate the diagram obtained from the indicator. (Webster)

Dial. 1. A compass fitted with sights, spirit levels, and vernier, for making underground surveys. 2. To survey with a dial and chain. *See* Dialing. (Gresley)

Dialing; Dialling. The operation of making a survey with the dial. (Gresley)

Diallage. The variety of monoclinic pyroxene which, in addition to the prismatic cleavages, has others parallel to the vertical pinacoids. Used also as a prefix to many rocks containing the mineral. (Kemp)

Dialysis. The separation of crystalloids and colloids in solution, by means of their unequal diffusion through certain natural or artificial membranes. (Webster)

Diamagnetic. Possessing or pertaining to the property of being repelled by a magnet and of tending to take a position at right angles to the magnetic force. (Webster)

Diamant. A Middle English form of spelling diamond.

Diamante (Sp.). Diamond; *D. en bruto*, a rough diamond; *D. negro*, a bort. (Halse)

Diamond. 1. A very hard, native crystallized form of carbon, C. When pure and clear it is used as a gem (U. S. Geol. Surv.). Although commonly colorless, is sometimes green, yellow, brown, blue, or black. *See also* Bort.
2. (Aust.). A pointed wooden or iron arrangement placed between rails, just before a curve, where skips are liable to be derailed, so as to enable them to mount the rails again. If the skips are traveling in one direction only, the diamond is pointed at one end, if traveling backwards and forwards on the same rails both ends are pointed. (Power)

Diamond chisel. A cutting chisel having a diamond or V-shaped point. (Gresley)

Diamond cutting. One of the three processes by which diamonds are prepared for use as ornaments or in the arts, the others being diamond cleaving and diamond polishing. (Century)

Diamond drill. A form of rotary rock drill in which the work is done by abrasion instead of percussion, black diamonds (borts) being set in the head of the boring tool (Raymond). Used in prospecting and development work where a core is desired.

Diamond dust; Diamond powder. A fine dust produced in diamond cutting by the abrasion of two stones against each other. (Century)

Diamond groove. A groove of V-section in a roll. (Raymond)

Diamond hitch. An interlacing of ropes forming a diamond on top of the pack. Used in tying a pack on an animal. (Webster)

Diamond saw. A circular disc having diamonds (or diamond dust) set in its cutting edge. It is employed for sawing stone.

Diamond spar. Corundum. (Power)

Diamond system (Eng.). Boring or prospecting for coal or ore with diamond drills.

Diamond tin. Large bright crystals of cassiterite. (Power)

Diamond wheel. A wheel made of metal, as copper or iron, and charged with diamond powder and oil, used in grinding gems.

Diaphaneity. The state or quality of allowing light to pass through. Used in describing mineral. *Compare* Transparent, Semi-transparent, Translucent, and Opaque. (Dana)

Diaphanous. Allowing light to show or shine through. (Webster)

Diaphorite. A mineral like freieslebenite in composition, $(Pb.Ag_2)_3Sb_2S_{11}$, or $5(Pb,Ag_2)S.2Sb_2S_3$, but orthorhombic in form. (Dana)

Diario (Colom.). 1. The daily quantity of amalgam produced by a mill. 2. The mill diary or record of hours, tonnage, etc. (Halse)

Diaschistic. Derived from a larger, parent igneous mass, but differing therefrom in composition; said of certain dikes associated with igneous intrusions. Contrasted with Aschistic. (La Forge)

Diaspore. An aluminum hydroxide mineral, $Al_2O_3.H_2O$. (Dana)

Diastatic. Pertaining or due to the movements of the forces which produce deformation of the earth's surface. (Standard)

Diastrophe. In geology, an event characterized by a deformation of the earth's crust. (Standard)

Diastrophism. The process or processes by which the crust of the earth is deformed, producing continents and ocean basins, plateaus and mountains, flexures and folds of strata, and faults. Also, the results of these processes. (Webster)

Diathermic. Allowing a free passage of heat. (Webster)

Diatom. A minute plant which is provided with a siliceous envelope. (Duryee)

Diatomaceous earth. A friable earthy deposit composed of nearly pure silica and consisting essentially of the frustules of the microscopic plants called diatoms; diatomite. Sometimes wrongly called infusorial earth, which *see*. (La Forge)

Diatomic. Consisting of two atoms to the molecule. Bivalent. Having two replaceable atoms or radicals. (Webster)

Diatomite (Eng.). The silica of diatoms dried to a fine powder and used in the manufacture of dynamite, pottery glaze, etc. (Standard.) *See also* Infusorial earth.

Diatomous. Having a single distinct diagonal cleavage, as in certain crystals. (Webster)

Diatom prism. A prism attached to a microscope to give the oblique illumination for observing very fine markings. (Standard)

Diatreme. A vent occurring in a surface fissure in volcanic regions. (Daly, p. 252)

Dibhole (Eng.). The lowest part of a mine, into which the water drains (Standard). A sump.

Dibujo (Sp.). A drawing; design or draft. (Halse)

Dice coal (Leic.). Layers in a coal seam which naturally break or split into small pieces resembling dice. (Gresley)

Dice mineral. A Wisconsin term for small cubic galena. (Power)

***Dicy* lode** (Corn.). A lode possessing many horizontal joints. (Power)

Dichroism; Pleochroism. The property of exhibiting different colors in different directions by transmitted light. (Dana)

Dichroite. A hydrated, aluminum-magnesium-iron silicate mineral, $H_2(Mg, Fe)_4Al_3Si_{10}O_{37}$. Synonymous with Iolite and Cordietrite.

Dichromic. Containing two atoms or equivalents of chromium. (Webster)

Dichroscope. An instrument for observing pleochroism in minerals. (A. F. Rogers)

Dickinsonite. A green, hydrous phosphate mineral, chiefly of manganese, iron and sodium. (Dana)

Diclinic. A crystal having two of the three axes inclined to the third and perpendicular to each other. (Standard)

Didymium. A supposed element announced by Mosander in 1841. The most recent investigations have shown that it is a mixture of two elements, neodymium and praseodymium. (Century)

Die. 1. A piece of hard iron, placed in a mortar to receive the blow of a stamp, or in a pan to receive the friction of the muller. Between the die and the stamp or muller the ore is crushed (Raymond). At Clunes, Victoria, it is called the Stamp bed. 2. A tool used for cutting threads, usually at one passage. (Nat. Tube Co.)

Die-earth (Eng.). A local term at Coalbrook Dale for the Wenlock shale, because this stratum lies beneath all the mining ground of the district—the minerals "dying out," as it were, at this stratum. (Page)

Diehl process. A modification of the cyanide process in which cyanogen bromide is added to the leaching solution. (Liddell)

Diente. 1. (Sp.). A tooth or cog; *D. de murciélago*, stibnite in cavities in veins; *D. de perro* (Colom.), a crystallized and opaque quartz occurring in geodes. (Halse)
2. (Mex.) Binding stone in Mexican masonry. *See* Tizón. (Dwight)

Diesel engine. An internal combustion engine in which only air is drawn in by the suction stroke, and the air is so highly compressed that the heat generated ignites the fuel which is automatically sprayed into the cylinder under high pressure. (Webster)

Die-stock. A contrivance for holding dies used in screw cutting (Century). *See* Die, 2.

Difference of potential. The difference in electrical pressure existing between any two points in an electrical system or between any point of such a system and the earth, as determined by a voltmeter. (Clark)

Differential flotation. The floating of one flotative mineral only, when there are others present which are ordinarily flotative. *See* Selective flotation and Preferential flotation. (O. C. Ralston, U. S. Bur. Mines)

Differential pumping engine. A compound direct-acting pumping engine, generally of the horizontal class. (Gresley)

Differentiation. The process or processes whereby cooling magma separates into rocks of different kinds, usually connected by gradations. (Ransome)

Diffraction. A modification which light undergoes in passing by the edges of opaque bodies or through narrow slits or in being reflected from ruled surfaces, in which the rays appear to be deflected producing fringes of parallel light and dark or colored bands. (Webster)

Diffusate. In chemistry, material which, in the process of dialysis, has diffused or passed through the separating membrane. (Webster)

Dig. 1. To mine coal; applied to bituminous workings (Chance). *See also* Gouge, 3.
2. To excavate; make a passage into or through, or remove by taking away material. (Century)

Digger. 1. One who digs, as a miner; a seeker of gold. A tool for digging. (Webster)
2. A man who is paid by the ton, for coal produced. A miner in the stricter sense. Originally the digger mined or undermined the coal. The term is now applied to the man who merely shoots out the coal. (Steel)
3. A machine for removing coal from the bed of streams, the coal having washed down from collieries of culm banks above. (C. and M. M. P.)

Digging. 1. Mining operations in coal or other minerals. (Hargis)
2. Region; locality; quarters; lodging (Webster). *See also* Diggings.

Diggings. Applicable to all mineral deposits and mining camps, but in usage in the United States applied to placer mining only (Raymond). *See also* Bar-Diggings.

Dihedral. Having two sides, as a figure; having two faces, as a crystal. (Century)

Dihydrite. A dark emerald-green, hydrous copper phosphate, $Cu_3P_2O_8 \cdot 2Cu(OH)_2$. mineral, crystallizing in the monoclinic system. (Dana)

Dike. 1. A long and relatively thin body of igneous rock, which, while in a state of fusion, has entered a fissure in older rocks and has there chilled and solidified (Century). Not to be confounded with vein. Also spelled Dyke. 2. A channel or ditch made for water by digging. 3. A bank of earth or stone; a levee. (Webster)

Dikelet. A small offshoot or apophysis from a dike. (Standard)

Dillue (Corn.). To sort (tin ore) by washing in a hand sieve. (Webster)

Dilluer (Corn.). A fine hair sieve for tin ore. (Century)

Dilluing; Dilleughing (Corn.). An operation performed in tin dressing upon the slimes of a certain part of the process. It is like the operation of panning, only performed with a sieve having a close haircloth bottom, and in a kieve of water which receives the tailings of the process. (Raymond)

Dilly. 1. (No. of Eng.) A counterbalance mounted upon two pairs of tram wheels by means of which the empty tubs are carried up an underground incline of a greater inclination than 1 in 3. (Gresley). A short self-acting incline where one or two tubs are run at a time. (C. and M. M. P.)
2. Any of various vehicles, as a light wagon, truck, water cart, etc. (Webster)

Dilly boy. One who rides a dilly or attends it.

Dilsh (Wales). Inferior coal in a thin stratum; culm. (Gresley)

Diluent. That which dilutes, or makes more fluid; a fluid that weakens the strength or consistence of another fluid upon mixture. (Century)

Diluir (Sp.). To dilute. (Dwight)

Diluvial. 1. Pertaining to floods. 2. Related to or consisting of diluvium. (Century)

Diluvium. 1. Sand, gravel, clay, etc., in superficial deposits. *See* Drift, 6. According to some authors, alluvium is the effect of the ordinary, and diluvium of the extraordinary action of water. The latter term is now passing out of use as not precise, and more specific names for the different kinds of material are substituted. (Raymond)
2. A name formerly applied to the unsorted and sorted deposits of the Glacial period, as contrasted with the later water-sorted alluvium. *Compare* Alluvium. (Kemp)

Dimension stone. Stone that is quarried or cut in accordance with required dimensions. (Ries)

Dimension work. Masonry consisting of stones whose dimensions are fixed by specification. (Century)

Dimetian rock. A granitoid and schistose rock, found in Wales lower than the Arvonian. (Standard)

Dimorfo (Sp.). Dimorphous. (Dwight)

Dimorphism. Crystallization in two independent forms of the same chemical compound, as of calcium carbonate occurring as calcite and aragonite. (Webster)

Dimorphite. An orange-yellow arsenic sulphide mineral that is obtained as a volcanic product, and is closely related to orpiment. (Standard)

Dinamita (Sp.). Dynamite. (Dwight)

Dinamo (Sp.). Dynamo. (Dwight)

Dinantian. In the usage of many European authorities, the oldest of the three series of strata comprised in the Carboniferous system in Europe; Lower Carboniferous. Equivalent to the Mississippian of North America. Also the corresponding epoch of geologic time. (La Forge)

Dinas brick. A refractory brick, almost entirely composed of silica from the Dinas clay in the Vale of Neath, England. (Raymond)

Dineral (Sp.). A standard of weight equal to 288 grains, used in assaying. (Halse)

Dinero (Sp.). 1. Money. 2. A standard weight of silver, the twelfth part of a *dineral*, and equal to 24 grains. (Halse)

Dingle (Eng.). A narrow valley between hills. (Humble)

Ding's magnetic separator. An ore separator on which the material is fed upward by a vibrating conveyor and passes through successive zones of magnetic separation. These zones are covered by the rims of rotating wheels which carry secondary magnets. These carry the magnetic particles out of the fields, are demagnetized, and drop the concentrate. (Liddell)

Dinite. An inodorous, tasteless, fragile mineral having the appearance of ice, but with a yellow tinge, and very soluble in ether and carbon disulphide; it was found in a lignite deposit at Lunigiana, Tuscany. (Bacon)

Dinky. A small locomotive used to move cars in and about mines and quarries. (Bowles)

Dint (Mid.). *See* Bate, 1.

Diopside. A natural calcium-magnesium silicate, $CaMg(SiO_3)_2$. A variety of pyroxene. (U. S. Geol. Surv.)

Dioptase. A hydrous silicate mineral of copper, H_2CuSiO_4. (Dana)

Diorita (Sp.). Diorite. (Dwight)

Diorite. A granitoid rock composed essentially of hornblende and feldspar which is mostly or wholly plagioclase, with accessory biotite and (or) augite. Minute grains of magnetite and titanite may be visible. Quartz may be present in considerable amount, in which case the rock is called quartz diorite. Quartz diorites grade into tonalites and granodiorites. (U. S. Geol. Surv.)

Diorite-porphyrite. A porphyrite whose groundmass is a finely crystalline diorite, and whose phenocrysts are prevailingly plagioclase. It is contrasted with hornblende-porphyrite, whose phenocrysts are prevailingly hornblende. (Kemp)

Dip. 1. The angle at which beds or strata are inclined from the horizontal, while underlie is the angle formed between a vein and a vertical line. The first is a geologist's term, the second a miner's. (Roy. Com.)
2. To slope downward from the surface. 3. (Eng.) A heading or other underground way driven to the deep. 4. A dip entry, dip room, etc. A heading driven to the full rise in steep mines. (Gresley)

Dip compass. *See* Dipping Compass.

Dip cut. In cutting out blocks of stone, the cut which follows a line at right angles to the strike. (Bowles)

Dip entry. An entry driven down hill so that water will stand at the face. If it is driven directly down a steep dip it becomes a slope (Steel). *See also* Entry; *also* Slope.

Dip fault. *See* Fault.

Dip-head. A heading driven downward on the dip of a coal seam. (Webster)

Dip-head level. A mine level connecting an engine-shaft (hoisting shaft) with the rooms or chambers (Standard). The main level, drift, or slope.

Dip joint. A vertical joint about parallel with the direction of the cleavage dip (C. and M. M. P.). *See also* Dip slip.

Dip needle. *See* Dipping compass.

Dippa (Corn.). A small pit sunk on a lode to catch water; a pit sunk on a bunch ore. (Duryee)

Dipper (No. of Eng.). A downthrow, or a fault. (Gresley)

Dipper dredge. A dredge in which the material excavated is lifted by a single bucket on the end of an arm, in the same manner as in the ordinary steam shovel. (Weatherbe)

Dipping. 1. (Wales). Same as Dip, 2. In Scotland it is called a dook. 3. In ceramics, the process of coating a coarse clay body with enamel or slip of a fine quality by plunging the vessel into the liquid material for coating. (Century)

Dipping compass. A compass having the needle fixed to swing in a vertical plane, so it can be readily deflected by magnetic rocks. (Weed)

Dipping needle. *See* Dipping compass.

Dipple (Eng.). Same as Dip, 3.

Dip shift. The component of the shift (or slip) parallel with the fault dip. (Lindgren, p. 122)

Dip side; Laigh side (Scot.). The lowest side of a room or wall. (Barrowman)

Dip slip. The component of the slip parallel with the fault dip, or its projection on a line in the fault surface perpendicular to the fault strike. (Lindgren, p. 121)

Dip-slip fault. *See* Fault.

Dip slope. *See* Escarpment.

Dip split. A current of intake air directed into or down a dip. (Gresley)

Dip switch (Ark.). A slant or piece of track connecting the back entry or air course of a dipping coal seam with the main entry or gangway. (Steel)

Dip throw. The component of the slip measured parallel with the dip of the strata. (Lindgren, p. 124)

Diputación de minería (Mex.). A local board, formerly elected in each district for the administration of all matters relating to the mining industry, abolished by the Law of 1892 and substituted by *agentes.* (Halse)

Dipyr. A variety of scapolite, often used as a prefix to the names of rocks that contain the mineral. (Kemp)

Dique (Sp.). 1. A mineral dike. 2. Dam. (Dwight)

Dirección (Sp.). Course; direction; strike. (Halse)

Direct draft. Having a single direct flue; applied to steam boilers. (Century)

Direct firing. The combustion of coal effected by burning directly on a grate. (Ingalls, p. 268)

Direction of strata. The strike, or line of bearing. (Hitchcock)

Direct process. A process which yields metal fit for use by a single process from the ore. The direct process for malleable iron is an ancient method, which has been to a considerable extent replaced by the indirect process in which cast iron is first made. (Webster)

Dirt (Eng.). 1. Clay, bind, or other useless waste produced in mining. 2. (No. of Eng.) Foul air or fire damp. (Gresley)
3. (Wisconsin zinc district.) Ore and waste as broken in the mines. 4. Auriferous gravel, wash, or pay dirt. (Skinner)
5. (Joplin, Mo.) Crude lead-zinc ore. The concentrate is called ore.

Dirt band. 1. A band of débris-filled ice alternating with clearer ice in a glacier. 2. *See also* Dirt bed, 1. (Oldham)

Dirt bed (or band). 1. (Eng.). A thin stratum of soft, earthy material interbedded with coal seams. (Gresley)
2. Old soil in which trees, fragments of timber, and numerous plants are found. (Oldham)

Dirt bing (Scot.). A débris heap (Barrowman). A waste heap.

Dirt fault. An area of crushed coal, or a partial or total replacement of the coal by a soft carbonaceous shale or slate with more or less coal running through the mass in thin stringers (Chance). Not a true fault.

Dirt scraper. A road scraper or a grading shovel, used in leveling or grading ground. (Century)

Dirt scratcher. A person whose duty it is to take down loose rock, clear away dirt, and perform such other like work as requires no special skill or experience. (Kellyville Coal Co. *v.* Humble, 87 Illinois App., p. 438)

Dirty coal (Scot.). A coal seam with thick partings of blaes or fire clay; a very ashy coal. (Barrowman)

Disc. *See* Tappet.

Discharge clack (Scot.). The delivery valve of a pump. (Barrowman)

Discharge, or issue. The expulsion of the pulp from a stamp-mill mortar. It is also used to designate the distance from the bottom of the screen to the top of the die, because this figure determines, more than any any other factor, the rapidity of the expulsion of the pulp. (Rickard)

Discission, space of. According to Posepny, a space or opening in or between rocks, formed by deformation of the rocks. Contrasted with Space of dissolution. (La Forge)

Discoidal. Having the form of a disk, quoit, or ordinary biscuit. (Sloan)

Discolith. A discoidal coccolith. (Webster)

Discordance. In geology, a lack of parallelism between contiguous strata. (Standard). An unconformity.

Discordant injection. An igneous mass injected across bedding planes. (Daly, p. 63)

Discordant stratification. Unconformable stratification (Hitchcock). *See also* Discordance.

Discovery (Pac.). The first finding of the mineral deposit in place upon a mining claim. A discovery is necessary before the location can be held by a valid title. The opening in which it is made is called Discovery - shaft, Discovery - tunnel, etc (Raymond). *See* Mine, 6, for "Discovery of a mine."

The finding of mineral in place as distinguished from float rock constitutes a discovery. (Book *v.* Justice Mining Co., 58 Fed. Rept., p. 120; Nevada Sierra Oil Co. *v.* Home Oil Co., 98 Fed. Rept., p. 676; Shoshone Mining Co. *v.* Rutter, 87 Fed. Rept., p. 807; Migeon *v.* Montana, etc., R. Co., 77 Fed Rept., p. 249; McShane *v.* Kenkle, 18 Montana, p. 208; 44 Pacific, p. 979; U. S. Min. Stat., p. 23; pp. 66–70)

Discovery claim. The first claim in which a mineral deposit is found, and when this is within a gulch or on a stream the claims are simply marked or numbered from the discovery claim either by letters or figures up or down the gulch or stream. Smith *v.* Cascaden, 148 Fed. Rept., p. 793)

Disfrute (Sp.). Exploitation of a mine; *Obras de D.*, stopes, etc.

Dish. 1. (Derb.) A rectangular box about 28 inches long, 4 inches deep, and 6 inches wide in which ore is measured. 2. (Corn.) A measure holding one gallon, used for tin ore dressed ready for the smelter. (Century)

3. (Corn.) The landowner's or landlord's part of the ore. (Raymond)

4. (No. of Eng.) The length or portion of an underground engine plane nearest to the pit bottom, upon which the empty tubs (cars) stand before being drawn inbye. (Gresley)

Dish plate (Eng.). A plate or rail concaved to receive the front wheels of a tub to secure it while emptying. (Webster)

Disintegration. The breaking asunder and crumbling away of a rock, due to the action of moisture, heat, frost, air, and the internal chemical reaction of the component parts of rocks when acted upon by these surface influences. (Roy. Com.)

Disintegrator. A machine for breaking coal into powder.

Disk. 1. A flat circular plate as of metal or paper (Webster)

2. The protecting plate or collar on a stamp shaft by which the cam lifts the shaft (Davies). *See also* Tappet.

Dislocación (Sp.). A fault as, in a vein. (Dwight)

Dislocar (Sp.). To displace; to fault. (Halse)

Dislocation. A shifting of the relative position of the rock on either side of a crack, or break. It may be up, down, or to one side. Equivalent to slip, slide, fault, throw, heave, upthrow, downthrow, trouble. (Roy. Com.)

Dispersion. In optical mineralogy, the optical constants for different parts of the spectrum. (A. F. Rogers)

Dispersoid. A body that has been dispersed in a liquid. (Rickard)

Disphenoid. In crystallography, a solid figure contained by eight isosceles triangles. (Standard)

Displacement. 1. The word "displacement" should receive no technical meaning, but is reserved for general use; it may be applied to a relative movement of the two sides of the fault, measured in any direction, when that direction is specified; for instance, the displacement of a stratum along a drift in a mine would be the distance between the two sections of the stratum measured along the drift. The word "dislocation" will also be most useful in a general sense. (Lindgren, p. 119)

2. The displacement of an air compressor is the volume displaced by the net area of the compressor piston. (A. I. M. E., Bull. 140, p. 57)

Displacement, horizontal. A term used by Tollman to designate Strike slip, *which see.* (Lindgren, p. 121)

Displacement, normal. A term used by Tolman to designate Dip slip, *which see.* (Lindgren, p. 121)

Displacement, total. A term used by Spurr and Tolman to designate Slip, *which see.* (Lindgren, p. 121)

Disposal (Scot.). The quantity of mineral sold. (Barrowman)

Disruptive. A term applied to that kind of force exerted by an explosive that tends to shatter the rock into fragments. (Bowles)

Dissected. Cut by erosion into hills and valleys or into flat upland areas separated by valleys. Applicable especially to plains or peneplains in process of erosion after an uplift. (Ransome)

Dissection. In geology, the work of erosion in destroying the continuity of a relatively even surface by cutting ravines or valleys into it. (Ransome)

Disseminated. To be scattered or diffused through; to be permeated with. (Roy. Com.)

Disseminated deposit. *See* Disseminated ore.

Disseminated ore. Ore carrying fine particles of metallic minerals, usually sulphides, scattered through rock or gangue matter, and without genetic significance. (Lindgren, p. 68)

Dissociate. In chemistry, to resolve, through variation of some physical condition, into simpler substances that are capable of reuniting to form an original one. (Century)

Dissociation. The act or process consisting in the reversible re-solution or decomposition of substances, with complex molecules, into those with simpler ones, when produced by a variation in physical conditions; also the state resulting from such process. (Century)

Dissolution. The act or process of dissolving or breaking up. A separation into component parts. (Webster)

Dissolution, space of. According to Posepny, a space or cavity in or between rocks, formed by the dissolving away of rock material. Contrasted with Space of discission. (La Forge)

Dissolving tank. A small tank used for dissolving solid cyanide and preparing a concentrated solution. (Clennell, p. 280)

Dissuing (Corn.). Cutting out the selvage or gouge of a lode to facilitate the extraction of ore. (Raymond). *See also* Zur.

Distance blocks. Wooden blocks placed in between the main spears and the side pump rods by which the proper distance between them is adjusted. (Gresley)

Disthene. Synonym for Kyanite; sometimes used as a prefix in rock names. (Kemp)

Distillate. The product of distillation, as petroleum distillate.

Distillation. Volatilization, followed by condensation to the liquid state. (Raymond)

Distillation furnace. A reverberatory heating furnace in which the charge is contained in a closed vessel and does not come in contact with the flame. It has a combustion chamber in which the gases are burned around the retorts containing zinc ore, the retorts resting on shelves inside the chamber. (Ingalls, p. 381)

Distillation, of petroleum. The process by which heat is applied to the crude oil in order that its constituents may pass off in vapor, and by suitable arrangements subsequently collected in the form of a liquid. (Mitzakis)

Distortion. The act of distorting or twisting out of place, or out of shape. (Hitchcock)

Distributive fault. *See* Fault.

Distributor. 1. A device for distributing the charge when dumped into blast furnace. (Willcox)
2. An apparatus for distributing an electric current, either to various points in rotation, as in some motors, or along two or more lines in parallel, as in a distributing system. (Webster)

District. 1. In the States and Territories west of the Missouri (prior to 1880), a vaguely bounded and temporary division and organization made by the inhabitants of a mining region. A district has one code of mining laws, and one recorder (Raymond). Counties and county officers have practically taken the place of these cruder arangements.
2. A limited area of underground workings. (Gresley)

District rope (Aust.). A rope used for hauling skips in a district or section of a colliery. (Power)

Disturbance. The bending or faulting of a rock or stratum from its original position. (Roy. Com.)

Disturbed. Said of an orebody when lacking defined walls and settled character. (Weed)

Ditch. 1. An artificial watercourse, flume, or canal, to convey water for mining. A flume is usually of wood; a ditch, of earth. (Raymond)
2. (Leic.) To clog; to impede. (Gresley)

Ditch drain. A gutter excavated in the floor of a gangway or airway to carry the water to the sump, or out to the surface. (Chance)

Ditched top (Leic.). A coal seam which has a hard unyielding top, and is with difficulty separated from the roof, is said to have a ditched top. (Gresley)

Ditcher; Circle cutting drill. A drill mounted on a frame that rotates about a central axis. It is used to cut circular trenches for the production of large grindstones. (Bowles)

Ditching. 1. Making of ditches. (Standard)
2. The digging or making of a ditch by the use of explosives. *See also* Propagated blast. (Du Pont)

Ditching car. A car provided with derricks and scoops to excavate ditches, as in a railway cut. (Standard)

Ditching machine. An excavating machine for digging trenches. (Standard)

Ditch water. The stale or stagnant water collected in a ditch. (Century)

Ditch wiring. The method of connecting electric blasting caps in such a way that the two free ends can be connected at one end of the line of holes. (Du Pont)

Ditroite. A nephelite-syenite from Ditro in Hungary, especially rich in blue sodalite. (Kemp)

Divide; Dividing range. The watershed or height-of-land from which the heads of streams flow in opposite directions. (Roy. Com.)

Dividing slate. A stratum of slate separating two benches of a coal bed (Chance). A parting.

Divinatoria. A divining rod. (Hooson)

Divining rod; Dowsing rod (Corn.). A rod (most frequently of witch-hazel, and forked in shape) used, according to an old but still extant superstition, for discovering mineral veins and springs of water, and even for locating oil wells. (Raymond)

Divisional planes. Planes which divide rocks into separate masses, large or small, in the same way as joints, fissures, and backs. (Roy. Com.)

Division rope (Aust.). *See* Buffer rope.

Dizzue (Corn.). *See* Dissuing.

D-link. A flat iron bar attached to chains, and suspended by a rope from a windlass. It forms a loop in which a man sits when lowered or raised in a shaft or winze. (Gresley)

Do (doo) (Leic., Derb.). *See* Bout, 2.

Doab. 1. A dark sandy clay found in the vicinity of many Irish bogs. (Power)
2. The tract of land between two streams immediately above their confluence. 3. The confluence of two streams. (Standard)

Doak; Donk (Derb.). Flucan. (Power)

Doar (Corn.). The earth; whence ore, the earth of metals. (Pryce)

Dobby wagon (York). A cart for conveying waste material (rock, etc.) from a mine. (Gresley)

Dobie. A term applied to the mud cap or *adobe* method of secondary blasting. *See also* Mud cap.

Dobla (Peru). Night shift (Dwight). In Chile, a double shift. (Halse)

Doblar (Sp.). To bend; to work two shifts in succession. (Dwight)

Dócil (Sp.). Docile; malleable; free milling. (Dwight)

Dock. 1. (N. Y. and Pa.) A local term among bluestone quarrymen and dealers for yards where the bluestone is unloaded as hauled from the quarries, and reloaded for transportation by rail or water to its destination. (Bowles)
2. A crib for holding loose or running rock from obstructing a track or passageway. (Sander, p. 115)

Dodd buddle. A round table resembling in operation a Wilfley table, and also like the Pinder concentrator (*which see*) except that it is convex instead of concave. The table does not revolve but has a peripheral jerking motion imparted to it circumferentially by means of a toggle movement. (Liddell)

Dodecahedral cleavage. In crystallography, cleavage parallel to the faces of the rhombic dodecahedron. (La Forge)

Dodecahedral mercury. Native amalgam containing 75 per cent mercury and 25 per cent silver. (Humble)

Dodecahedron. 1. In crystallography, an isometric form composed of twelve faces, each parallel to one axis and intersecting the other two axes at equal distances: specifically named the rhombic dodecahedron. 2. An isometric form composed of twelve faces, each parallel to one axis and intersecting the other two axes at unequal distances: Specifically named the pentagonal dodecahedron; also called Pyritohedron. (La Forge)

Dodecant. In crystallography, in the hexagonal system, one of the twelve parts into which the space about the center of symmetry is divided by the axial planes of symmetry. (La Forge)

Dodge crusher. Similar to Blake crusher, except the movable jaw is hinged at the bottom. Therefore the discharge opening is fixed, giving a more uniform product than the Blake with its discharge opening varying every stroke. (Liddell). This type of crusher gives the greatest movement on the largest lump.

Dodge pulverizer. A hexagonal barrel revolving on a horizontal axis, containing perforated die plates and screens. Pulverizing is done by steel balls inside the barrel. (Liddell)

Dog. 1. Any of various devices for holding, gripping or fastening something. 2. A drag for the wheel of a vehicle. (Webster)
3. (Scot.) A hook-headed spike for fastening down flat-bottomed rails.
4. (Scot.) A spring hook, most commonly in use for attaching a sinking bucket to the winding rope. (Barrowman)
5. An iron bar, spiked at the ends, with which timbers are held together or steadied. (Gresley)
6. A short heavy iron bar, used as a drag behind a car or trip of cars when ascending a slope to prevent them running back down the slope in case of accident. A drag. (Steel)
7. *See* Casing dog; *also* Pipe dog.

Dog-and-chain. 1. An iron lever with a chain attached by which props are withdrawn. (Gresley)
2. *See* Dog belt.

Dog belt (Mid.). A strong broad piece of leather buckled round the waist, to which a short piece of chain is attached, passing between the legs of the man drawing a dan (tub) in a mine. (Gresley)

Dog clip (Aust.). Same as Clip.

Dogger. 1. (Clev.). A bed of inferior ironstone overlying the main seam. (Gresley)
2. (Scot.). An irregular piece of stony coal in a seam. (Barrowman)

Doggy (So. Staff.). An underground superintendent, employed by the butty. (Raymond)

Doghole. A small opening from one place in a coal mine to another; smaller than a breakthrough. (Steel)

Dog hook. 1. (Eng.) A long hook for drawing an empty wagon. (Bainbridge)
2. A strong hook or wrench for separating iron boring rods. 3. An iron bar with a bent prong, used in handling logs. (Century)

Dog house. 1. (Joplin, Mo.) A washroom; dry house; change house. 2. (Joplin) A box or platform on which a can or bucket rests at the bottom of a shaft. 3. In furnace practice, *See* Forechamber.

Dog iron. A short bar of iron with both ends pointed and bent down so as to hold together two pieces of wood into which the points are driven, or one end may be bent down and pointed, while the other is formed into an eye, so that if the point be driven into a log, the other end may be used to attach a chain for hauling. (C. and M. M. P.)

Dog-on; Dug-on (Scot.). To put the hutches on the cage. This term probably had its origin in the hooking of the bucket to the rope by means of a dog hook. (Barrowman)

Dogs. 1. (Eng.) In the plural: Bits of wood at the bottom of an air door (Bainbridge). 2. *See also* Cage shuts. 3. *See* Dog, for various other meanings.

Dogstone. A rough or shaped stone used for a millstone. (Century)

Dogtooth spar. A variety of calcite with sharp-pointed crystals. (Standard)

Dogwatch (Aust.). The night shift in a colliery (Power). *See also* Graveyard shift.

Doit (Eng.). Foulness, or damp air. (Bainbridge)

Dol (Corn.). Pronounced doll. A valley or dale. (Pryce)

Dôl (Corn.). Any part or share of the adventure or tin ore, as one-eighth, one-sixteenth, one-thirty-second, or the like. (Pryce)

Dol-eôth. An old field or meadow; an old valley or dale. The name of a great mine in Camborne, Cornwall. (Pryce)

Dole. A division of a parcel of ore. (Raymond). Also spelled Dôl.

Dolerita (Mex.). Dolerite. (Dwight)

Dolerite. Coarsely crystalline basalt. The word has had a somewhat variable meaning during its history and among different peoples. The English use it in place of diabase; indeed the definition given here justifies this usage, except that the characteristic texture of diabase is not essential to this definition of dolerite. But the diabasic texture is more of a microscopic feature than a megascopic. (Kemp)

Doline. In geology, one of the natural funnel-form water tubes worn down vertically through limestone strata to their underground drainage. (Standard)

Dolly. 1. (Aust.) An instrument used for breaking and mixing clay in the puddling tub. 2. A heavy timber shod with iron, and hung from a tree or other support and formerly used for crushing quartz. (Davies) 3. To break up quartz with a piece of wood shod with iron, in order to be able to wash out the gold. (Skinner)
4. A device consisting of a small platform and a single wide roller, used as a truck for timber, etc., or when inverted as a stationary roller. (Webster)
5. (So. Staff.). A cast-iron weight used when men ride in the shaft, to act as a counter-balance to the winding engine. (Gresley)
6. A tool for sharpening machine-drill bits. (Gillette, p. 53)
7. To concentrate (ore) by use of a dolly tub. 8. A wooden disk for stirring the ore in a dolly-tub, in ore-concentration by the tossing and packing process (Standard). *See also* Dolly-tub.

Dolly tub (Corn.). A tub in which ore is washed, being agitated by a dolly, or perforated board (Raymond). *See also* Dolly, 7 and 8.

Dolomia (Mex.). Dolomite. (Dwight)

Dolomite. 1. A carbonate of calcium and magnesium, (Ca, Mg) CO_3. (U. S. Geol. Surv.)
2. A term applied to those rocks that approximate the mineral dolomite in composition. Named by Saussure, after Dolomieu, an early French geologist (Kemp). Also called Magnesian limestone. It occurs in a great many crystalline and noncrystalline forms the same as pure limestone, and among rocks of all geological ages. When the carbonate of magnesia is not present in the above proportion the rock may still be called a magnesian limestone, but not a dolomite, strictly speaking. (Roy. Com.)

Dolomite limestone. *See* Dolomite, 2.

Dolomitic. Composed of or similar to dolomite. (Century)

Dolomitization; Dolomization. The process whereby limestone becomes dolomite by the substitution of magnesium carbonate for a portion of the original calcium carbonate. If the $MgCO_3$ approximates the 45.65 per cent. of the mineral dolomite, there is great shrinkage in bulk, leading to the development of porosity and cavities up to 11 per cent. of the original rock. (Kemp)

Dome. 1. To swell upward like a dome. 2. The upper part of a furnace. 3. The vertical steam chamber on top of a boiler. 4. A crystal form composed of planes parallel to a lateral axis which meets in a horizontal edge like the roof of a house. 5. In geology, an uplift in which the beds dip outward in all directions from a center (Webster). Oil and gas pools are frequently found beneath domes.

Domeykite. A reniform and botryoidal, tin-white to steel-gray copper arsenide, Cu_3As; also found massive and disseminated. (Dana)

Domite. A more or less decomposed trachyte from the Puy de Dome in the French volcanic district of the Auvergne. The typical domite contains oligoclase and is impregnated with hematite. (Kemp)

Donk (No. of Eng.). Clay or soft earth, found in cross veins and flats (Davies). *See also* Doak.

Donkey. *See* Barney. Also used synonymously for Donkey engine, Donkey pump, Donkey hoist.

Donkey engine. A small auxiliary engine. (Webster)

Donkey hoist. An auxiliary hoisting engine operated by steam or compressed air.

Donkey pump. Any of several kinds of combined pump and steam engine. It may be operated independently of the engine: Used to supply water to a boiler, drain sumps, etc.

Donnick; Donock; Donnock. A variation of Dornick.

Dook. 1. (Scot.) A mine or roadway driven to the dip, usually the main road (Barrowman). *See also* Slope. 2. (Som.) An underground inclined plane. (Gresley)

Dook workings (Scot.). Workings below the level of the shaft bottom. (Barrowman)

Door. A movable frame or barrier of boards, or other material, usually turning on hinges or pivots, by means of which a passage way may be opened or closed (Webster). Doors are placed in air passages of mines to prevent the ventilating current from taking a short cut to the upcast shaft, and to direct the current to the working face.

Door chain (Scot.). A chain with adjusting screw by which the bucket and clack door of a pump are suspended. (Barrowman)

Door heads (Scot.). The roof or top of the workings at a shaft. (Barrowman)

Doorpiece. That portion of a lift of pumps which contains the clack or valve. (Duryee)

Doorstead. 1. (Eng.). Upright timbers in the sides of levels for supports. (Bainbridge)
2. The entrance or place of a door. (Webster)

Door stoop (Scot.). A pillar or block of mineral left around a shaft for its protection. (Barrowman)

Door tender. A boy whose duty it is to open and close a mine door before and after the passage of a train of mine cars. Also called Trapper. (Steel)

Door trapper. *See* Door tender.

Dope. An absorbent material; especially in high explosives, the sawdust, infusorial earth, mica, etc., mixed with nitroglycerin as in dynamite. (Webster)

Dopplerite. An asphalt found in New Zealand and some parts of Siberia. It resembles elaterite. (Mitzakis)

Doré. Gold and silver bullion which remains in a cupelling furnace after the lead has been oxidized and skimmed off. (Bull, 98, U. S. Bur. Mines, p. 70)

Doré bullion. Same as Base bullion. *Compare* Doré.

Dor furnace. A regenerative zinc-distillation furnace with heat-recuperating chambers at the ends of the furnace instead of beneath the combustion chamber. (Ingalls, p. 463)

Dornick; Dornock (U. S.). A small rock or bowlder; specifically a bowlder of iron ore found in limonite mines (Webster).

Dorongee (pronounced duruni) (Assam, India). A gold-washing trough. (Lock)

Dorr agitator. An agitating machine based on the thickener principle. It is essentially a Dorr classifier equipped with a central air lift. (Liddell)

Dorr classifier. A machine to diminish the amount of water required for classification by raking the heavier grains up an inclined plane against a light current of water, which washes away the lighter material. It is of the intermittent type. (Liddell)

Dose. A special charge used in a blast furnace, designed to cure furnace troubles. (Willcox)

Dott; Dott-hole. A small opening in the vein. (Raymond)

Double-acting pump. (Scot.). A pump which discharges at both forward and backward stroke. (Barrowman)

Double bank. 1. To take up a claim parallel with and adjoining another claim containing an auriferous vein or lead. 2. Working with double sets or relays of men. (Duryee)

Double-bank cages (Wales). Cages having two decks, or a multiple of two, so that decking (caging) may be performed at two levels or banks. (Gresley)

Double core-barrel drill. A core drill having an inner tube that is suspended on ball bearings and thus may remain still while the outer tube revolves. It is designed to bring out a core from a delicate material with a minimum of breaking or other damage. (Bowles)

Double crib (Eng.). Two wedging cribs placed one on the top of another. (Gresley)

Double-diamond bottom (Ark.). An arrangement of track at the shaft bottom consisting of two parallel tracks (one to each compartment of the shaft) with a double crossover track between them and repeated on each side of the shaft. (Steel)

Double-entry. 1. A pair of entries in flat or gently dipping coal so laid out that rooms can be driven from both entries; twin entries (Steel). *See also* Entry.
2. A system of ventilation by which the air current is brought into the rooms through one entry and out through a parallel entry or air course. (Steel)

Double-entry room-and-pillar mining. *See* Room-and-pillar method.

Double-handed gear (Newc.). Heavy drilling tools which require two men to use them. (Min. Jour.)

Double header. A term applied to *quarry* equipment consisting of two independent channeling machines on a single truck, operated by one man. (Bowles)

Double-image prism. A prism made of Iceland spar, giving two images of equal intensity, but polarized at right angles to each other. (Standard)

Double load. A charge in a bore hole separated by a quantity of inert material for the purpose of distributing the effect, or for preventing part of the charge blowing out at a seam or fissure, in which case the inert material is placed so as to include the seam. (Du Pont)

Double-men. *See* Double-pick.

Double, or Duplex hammer. A forging device striking on opposite sides, as of a bloom. (Standard)

Double-pick; Double-men (Corn.). Two men who use one pick, one during the day, and one at night, so that the pick is kept constantly at work. (Pryce)

Double-refracting spar. Same as Iceland-spar.

Double refraction. Refraction shown by certain crystals that split the incident ray into two refracted rays, polarized in perpendicular planes. (Standard)

Double-room system. *See* Room-and-pillar method.

Doubles (Som.). The repeated folds or overlaps of the coal strata in the Radstock district. (Gresley)

Double-shear steel. Converted steel that has been twice fagoted and drawn out. (Standard)

Double shift. 1. Two sets of men at work, one set relieving the other.
2. To employ two shifts of men, or to work double shift. (Steel)

Double stall (Wales). A system of working coal in which the roof falls within chambers of a limited width. (Gresley)

Double-tape fuse. Fuse of superior qualtity, or having a heavy and strong covering. (C. and M. M. P.)

Double timber (Wales). Two props and a bar placed across the tops of them to support the roof and sides of a heading. (Gresley)

Double working (No. of Eng.). Two hewers (miners) working together in the same heading. (Gresley)

Doubling. 1. A process for the treatment of antimony sulphide by fusing it with iron or other antimony containing iron, so as to form an iron sulphide, the removal of which eliminates both iron and sulphur. (Webster)
2. (Scot.) Thickening of a seam, sometimes due to its being folded over or doubled (Barrowman). *See also* Doubles.

Douce. *See* Douse.

Douglas furnace. A horizontal, revolving cylindrical furnace having a central flue. (Ingalls, p. 160)

Douglas process. *See* Hunt and Douglas process. (Raymond)

Douk; Douke; Dowk (Eng.). A soft clay found in veins. Probably derived from the Saxon *deagan*, to knead or mix with water. (Hunt)

Doup out (Scot.). To connect a drift with one formerly driven in stoop-and-room workings. (Barrowman)

Dour holing (Scot.). Difficult undercutting in hard coal or stone. (Barrowman)

Douse; Dowse. 1. To beat out or extinguish an ignited jet of fire damp (Gresley). Also spelled Douce.
2. To search for deposits of ore, for lodes, or water, by aid of the dousing or divining rod. (Century)

Dowk (No. of Eng.). A dark-colored clayey material forming part of a vein (Standard). *See also* Douk.

Down (Eng.). Underground; in the pit. (Gresley)

Down brow (Lanc.). A dip incline underground. (Gresley)

Downcast. 1. The shaft through which the fresh air is drawn or forced into the mine; the intake (Steel; Coal Run Coal Co. *v.* Jones, 127 Illinois, p. 381)
2. (Eng.) A fault which throws a coal seam downwards. *See also* Downleap. (Gresley)

Downcomer. A pipe to conduct something downward, as a pipe for leading hot gases from the top of a blast furnace downward to the regenerators, boilers, etc. (Webster). Sometimes called Downcome.

Downdraft. A downward draft as in a flue, chimney, shaft of a mine, etc. (Webster)

Down-draft kiln. A kiln in which the heat enters the chamber from the top and passes down through the ware. (Ries)

Downer (Som.). A rest or cessation from work, say half an hour, taken during a shift or turn. (Gresley)

Downfall (So. Staff.). A downthrow. (Min. Jour.)

Down holes. Drill holes that incline downward. (H. C. Hoover, p. 100)

Down-leap (Mid.). A dislocation of strata which has caused a coal seam to be aburptly cut off and brought below its original level. *See also* Downthrow. (Gresley)

Downs (Eng.). The rounded, dry, and unwooded chalk hills of Kent, Surrey, Sussex, and adjacent counties. (Page)

Downset (Scot.). A short drift to the dip. (Barrowman)

Down spouts (Lanc.). Pipes fixed down the sides of a shaft for conducting water from one level or sump to another. (Gresley)

Downthrow. Generally applied as meaning that side of a fault which has moved downward. This use is objectionable, since determinations of throw are always relative and it can rarely be told which side of the fault has moved. The term should be used with the definite understanding that it refers merely to a relative and not an absolute displacement. (Lindgren, p. 118)

Downward enrichment. A term which is synonymous with "secondary enrichment" as the latter has applied to enrichment of ore bodies by the downward percolation of waters.

Dowse. To use the dipping or divining rod, as in search of water, ore, etc. (Webster). *See* Douse.

Dowser. A divining rod for dowsing; also one who uses a divining rod (Webster). *See* Divining rod.

Dowsing rod; Dowzing rod (Som.). *See* Divining rod; *also* Dowser.

Dowson producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 305)

Dradge (Corn.). The inferior portions of ore, separated from the best ore by cobbing. (Raymond)

Dradgy lode (Eng.). A lode through which the mineral is so thinly disseminated as to be scarcely worth the expense of dressing. Such lode, ore-stuff, or stone is called dradgy. (Hunt)

Draft. 1. (Wales) Allowance coal. About 360 lbs. per week to every householder. (Gresley)
2. Act of drawing. 3. A load; the quantity drawn forward, up or out. 4. A current of any sort, as of air in a room or chimney. 5. The area of an opening or group of openings for the discharge of water, as the draft of a turbine wheel. (Webster)

Draftage. A deduction made from the gross weight of ore to allow for loss in transportation. (C. and M. M. P.)

Draft engine (Corn.). An engine used for pumping. (Min. Jour.)

Draft hole. An opening through which air is supplied to a furnace. (Century)

Drag. 1. A wooden or iron bar placed between the spokes of the wheels of trams to check their speed upon an inclined way. *See* Back stay (Gresley). A brake, or sprag.
2. An appliance to be attached to the rear of a loaded train of cars to prevent the cars from running down the incline or grade in case the cable should break. (Brookside Coal Min. Co. *v.* Hajnal, 101, Illinois App., p. 177; Brookside Coal Min. Co. *v.* Dolph, 101, Illinois App., p. 169)
3. The frictional resistance offered to a current of air in a mine. (Steel)
4. The lower part of a flask. The mold having been prepared in the two parts of the flask, the cope is put upon the drag before casting. After casting, the flask is opened by removing the cope. (Raymond)
5. Fragments of ore torn from a lode by a fault. Such fragments are scattered along the line of the fault and are usually inclosed within crushed or bracciated pieces of the rock traversed by that fault. Secondary mineralization along the fault may obscure the true character of the "drag" in which case the difference in associated minerals may prove suggestive. (Min. and Sci. Press, May 29, 1915.)
6. An iron blast-hole cleaner; drag-twist. 7. A runnerless sled for drawing rough heavy stone, etc.; a stone-boat. (Standard)

Draga (Sp.). 1. Dredge; dredger. 2. A miner's shovel. (Halse)

Dragagem; Dragaje (Port.). Dredging. (Halse)

Dragbar; Back stay (Aust.). An iron bar fastened to the back of a skip to prevent the latter running down hill in case the hauling rope breaks (Power). *See also* Drag, 2.

Drag bolt. A coupling pin. (Webster)

Drag chain. A chain to make fast a wheel of a vehicle so that the wheel will act as a drag.

Dragline scraper. A type of apparatus for the removal of soil. It consists of one or more buckets or scrapers attached to an endless cable or belt operated by a drum or sprocket wheel.

Dragon (So. Staff.) A barrel in which water is raised from a shallow shaft. (Gresley)

Dragonera (Peru). Passage of the flame into the furnace at the fire bridge. (Dwight)

Dragonite. A fabulous stone said to be obtained from the head of the flying dragon. Quartz crystals, found in gravel, which have lost their brilliancy and angular form, and consequently their identity, were formerly thought to have had the origin indicated above. (Pliny Hist., Bk. 37, p. 57)

Dragons' skin (Eng.). A familiar term among miners and quarrymen for the stems of Lepidodendron, whose rhomboidal leaf scars somewhat resemble the scales of reptiles. (Page)

Dragsman (No. of Eng.). A man employed as a pusher of tubs (cars) in underground working places. (Gresley)

Dragstaff. A pole projecting backward and downward from a vehicle, to prevent it from running backward. *See* Backstay; *also* Drag, 2.

Drag-stone mill. A mill in which ores, etc., are ground by means of a heavy stone dragged around on a circular or annular stone bed (Webster). *See* Arrastre.

Drag twist. A spiral hook at the end of a rod, for cleaning bore holes. (Raymond)

Drain. A ditch cut in a mine floor or bottom. (Roy)

Drainage basin. *See* Basin, 1.

Draught (So. Staff.) The quantity of coal hoisted in a given time (Raymond. *See* Draft, 3.

Draw. 1. (So. Staff.) Strictly speaking, the distance on the surface to which the subsidence or creep extends beyond the workings. (Gresley)
2. The effect of creep upon the pillars of a mine. 3. To draw the pillars; to mine out the pillars, or to pull or rob them after the rooms are worked out. Called Pull in Arkansas. (Steel)
4. (Scot.) The distance that mineral is hauled by trammers. (Barrowman)
5. In geology, a valley or basin. (Standard)
6. To raise ore, coal, rock, etc., to the surface; to hoist.

Draw a charge. To take a charge from a furnace. (C. and M. M. P.)

Draw bar. 1. A bar used to connect rolling stock, as a bar with a single eye at each end for coupling together a locomotive and its tender. (Webster)
2. A heavy beam under the body of a railway car and projecting at the end for coupling cars. Some arrangement for coupling is placed at the outer end, and springs at the inner end to lessen recoil in starting, coupling, etc. (Standard)

Drawer. 1. (Scot.) A man or boy who takes ore or rock from the working face to the shaft, or terminus of the horse or haulage road (Barrowman). One who pushes trams or drives a horse underground.
2. (Derb.) A man who hoists ore or rock by means of a windlass, or otherwise, from a shaft. (Hooson)

Drawhead. The head of a draw bar. (Webster)

Draw hole. An aperture in a battery through which the coal is drawn. (Chance)

Drawing. 1. Recovering the timbers, chocks, etc., from the goaves. This work is commonly performed with the use of the Dog-and-chain, *which see.* 2. Knocking away the sprags from beneath the coal after holing. 3. Raising coal, through a shaft or slope. (Gresley)
4. In hydraulic mining, throwing the water beyond the dirt to be removed and causing it to flow toward the giant (Hanks). *Compare* Goosing.

Drawing a jud. 1. (No. of Eng.) Bringing down the face of coal, by withdrawing the sprags. (Gresley)
2. *See* Jud, 4.

Drawing an entry. Removing the last of the coal from an entry. (Hargis)

Drawing engine (Eng.). A winding or hoisting engine. (Gresley)

Drawing lift. The lowest lift of a cornish pump, or that lift in which the water rises by suction (atmospheric pressure) to the point where it is forced upward by the plunger. (Century)

Drawing road (Scot.). An underground passage along which ore or coal is conveyed. (Barrowman)

Drawing small. When a winding rope, from the effects of wear and tear, has become less in diameter or in thickness from that cause, it is said to be "drawing small." (Gresley)

Draw kiln (Scot.). A lime-kiln in which the process of calcination is carried on continuously, the raw limestone and fuel being put in at the top and the lime withdrawn at the bottom. (Barrowman)

Drawlift. Same as Drawing lift.

Drawn. The condition in which an entry or room is left after all the coal has been removed. (Hargis)

Drawn clay. Clay that is shrunk or decreased in volume by burning. (Century)

Draw slate. A soft slate, shale or rock from two inches to two feet in thickness, above the coal, and which falls with the coal or soon after the coal is removed (Harr). (Lumaghi Coal Co. *v.* Grenard, 133 Illinois App., p. 30; Interstate Coal Co. *v.* Trivett, 155 Kentucky, p. 828)

Draw wood; Draw trees (Scot.). To extract and recover mine timbers. (Barrowman)

Dredge. 1. A scoop or suction apparatus, operated by power, and usually mounted on a flat-bottomed boat, for clearing out or deepening channels, harbors, etc., by taking up and removing mud or gravel from their bottoms. Extensively used in mining gold-bearing sand and gravel. For this purpose it is equipped with screening apparatus and gold-saving devices. Also called Dredging machine.
2. Inferior ore separated from the better ore by cobbing (Webster). Sometimes written Dradge.
3. Very fine mineral matter held in suspension in water. (Raymond)

Dredge boat. A boat bearing a dredging machine, especially one used in dredging river channels and in mining gold-bearing sand and gravel.

Dredger. 1. One who uses a dredge. 2. A boat employed in dredging. 3. A dredging machine. (Webster)

Dredge sump (No. of Eng.). A small reservoir at the bottom of a shaft, in which the water collects and deposits any sediments or débris. (Gresley)

Dredging. 1. The act of using a dredge. 2. The material brought up by a dredge. (Century)

Dredging machine. *See* Dredge, 1.

Dredging pump. A pump for drawing up silt, loose sand, etc., as in dredging (Standard).

Dredging tube. The large tube of a dredging machine that operates by suction for the removal of mud, sand, etc. (Standard)

Dredgy ore (Corn.). A rock impregnated with or traversed by minute veins of mineral (Min. Jour.). Also called Dradgy ore, or Drady trade.

Dreelite. A variety of barite. (Dana)

Dress. 1. To clean ore by breaking off fragments of the gangue from the valuable mineral (Whitney). *See* Ore dressing.
2. The furrowing on a millstone face. (Webster)

Dressants (Fr.). Very steep lying seams of coal, etc. (Gresley)

Dressed rocks. Same as Roches moutannées. (Standard)

Dresser. 1. (Mid.). A tool used by colliers and banksmen for splitting large lumps of coal, and for cleaning coal for the market. A nooper. (Gresley)
2. A tool or apparatus for cutting and dressing the furrows on the face of a millstone. (Century)
3. The superintendent of persons employed in picking, washing, and dressing ore. 4. In the plural, those persons engaged in ore dressing.

Dressing. 1. (Mid.) Trimming and cleaning up a stall face after the loaders have left off work. (Gresley)
2. (Corn.). The picking and sorting of ores, and washing, preparatory to reduction. (Raymond)

Dressing floor. The floor, place, or yard where ores are rough dressed or sorted.

Dressing works. *See* Concentrator; *also* Ore dressing.

Driblet-cone. A small fantastic cone, formed by the adhesion of congealing driblets of liquid lava from a volcanic blowhole: contrasted with cinder cone. (Standard)

Dries, or Dry. Seams in the rock, which are usually invisible in the freshly quarried material, but which may open up in cutting or on exposure to the weather. *See also* Dry, 1 and 2. (Ries)

Drift. 1. A horizontal passage underground. A drift follows the vein, as distinguished from a crosscut, which intersects it, or a level or gallery, which may do either. (Raymond)
2. In coal mining, a gangway or entry above water level, driven from the surface in the seam. (Steel)
3. (No. of Eng.) A heading driven on the strike of the coal seam. 4. (Forest of Dean) A hard shale. (Gresley)
5. To make a drift; to drive. (Webster)
6. Any rock material, such as bowlders, till, gravel, sand, or clay, transported by a glacier and deposited by or from the ice or by or in water derived from the melting of the ice. Generally used of the glacial deposits of the Pleistocene epoch. Detrital deposits. (La Forge)

Drift and pillar (No. Staff.). A system of working coal similar to the room and pillar system.

Drift-band (Ill.). A thin band or layer of soft earthy material occurring in a coal seam.

Drift-bed. In geology, a layer of drift of sufficient uniformity to be distinguished from associated ones of similar origin; a drift stratum. (Century)

Driftbolt. A bolt for securing together successive layers, as of stones in a foundation or of timbers in a grillage. (Webster)

Drift copper. Native copper found in gravel and clay, far from the original orebody, from which it has been carried by glaciers. (Weed)

Drift deposit. Any accumulation of glacial origin; glacial or fluvio-glacial deposit. (Century)

Drift epoch. Same as Glacial epoch.

Drifting. Opening a drift; driving a drift. *See also* Drift, 1, 2, and 3.

Drifting back (No. Staff.). The operation of mining the pillars toward the pit bottom as soon as the cross headings are driven. (Gresley)

Drifting curb. A wooden frame forced downward through quicksand, having planks driven at the back of it to keep out the sand and water. (Gresley)

Drift map. A map showing the distribution of various glacial and fluvio-glacial deposits, generally called drift. (Century)

Drift mine. A mine opened by a drift.

Drift mining. A method of mining gold-bearing gravel, or cement, by means of drifts and shafts, as distinguished from the process of hydraulic mining (Webster). *See* Placer mining.

Drift peat. A peat deposit associated with or embedded in glacial drift. (Century)

Drift scratches. Marks on the surface of solid ledges of rocks, supposed to have been produced by the grinding action of masses of soil, gravel and rocks, during glacial movement. (Jackson)

Drift slabs. Slabs of more than ordinary length, used especially for holding back dirt, sand and water from a shaft. (Duryee)

Drift stoping. *See* Sublevel stoping.

Driftway. *See* Drift, 1.

Driggoe (Corn.). The lower pump in a set or tier; the working piece. Also called Drigger. (Pryce)

Drill. 1. A metallic tool for boring in hard material. The ordinary miner's drill is a bar of steel with a chisel-shaped end, and is struck with a hammer. *See* Rock drill, Diamond drill. (Raymond)
2. To make a hole with a drill or similar tool. 3. *See* Drilling, as applied to oil and gas wells.

Drill core. A solid, cylindrical core of rock cut out by a diamond or shot drill. It forms a record of the strata through which the drill has passed. (Weed)

Driller. 1. One who or that which drills. 2. A drilling machine. (Standard)

Drill extractor. A device for withdrawing the drill bit from wells; drill tongs. (Standard)

Drilling. A term employed in a general way to denote the different processes employed for the discovery and extraction of petroleum or natural gas. Two general methods of drilling have come to be recognized: (*a*) Percussion systems, which consist of breaking up the ground by means of a sharp pointed instrument of a particular form, which is made to strike the ground in a series of blows; and (*b*) Rotary systems, which aim at the extraction of a core or permit all the disintegrated material to be washed away. (Mitzakis). Also commonly used in prospecting for, and in the development of ore or coal lands.

Drilling jig. A portable drilling machine worked by hand. (Century)

Drilling-up. Preliminary digging out the clay in the tap hole of a furnace. This is done usually by hand, air, or electric drill. (Willcox)

Drill-jars. *See* Jars.

Drill rod. A vertical rod bearing a drilling tool for boring wells. (Standard)

Drink time (Eng.) Meal time. (Bainbridge)

Drip. 1. A name given to an apparatus attached to natural-gas wells to exclude from the mains any liquid, such as oil or water, that may accompany the gas. It usually consists of four iron tubes placed vertically, the inner two being connected by a cross tube. During the passage of the gas through this apparatus, the liquid becomes separated and accumulates in a tube called a tail piece, from which it is blown out from time to time. (Mitzakis) Any opening arranged to take a liquid from a line carrying gas, as condensation from a steam line.
2. (Eng.) The dip of a stratum. (Webster)

Drip stone. 1. A porous stone, either artificial or natural, for filtering water. 2. Calcium carbonate in the form of stalactites and stalagmites. (Webster)

Drive. 1. To excavate horizontally, or at an inclination, as in a drift, adit or entry (Gresley). Distinguished from sinking and raising.
2. (Aust.) A level, drift, or tunnel in a mine. (Hanks)

Driven well. A well which is sunk by driving a casing, at the end of which there is a drive-point, without the aid of any drilling, boring, or jetting device. (Meinzer)

Drive pipe. 1. A pipe which is driven or forced into a bored hole, to shut off water, or prevent caving. (Nat. Tube Co.)
2. A thick type of casing fitted at its lower end with a sharp steel shoe, which is employed when heavy driving has to be resorted to for inserting the casing. (Mitzakis)

Drive-pipe ring. A device for holding the drive pipe while being pulled from well. (Nat. Tube Co.)

Driver. 1. A person who drives a horse or mule in a mine. (Roy)
2. One who controls the movements of a locomotive, motor car, or the like. (Webster)
3. (Eng.) A bit of iron for forcing the wood into a blasting hole (Bainbridge). A tamping iron.
4. (Eng.) A man who breaks down the coal in the stalls with hammers and wedges, after the holing is finished. A miner. (Gresley)

Driver boss. A person in charge of the drivers in a mine. (Steel) *See* Driver, 1.

Drive shoe. A protecting end attached to the bottom of drive pipe and casing. (Nat. Tube Co.)

Driving. 1. Extending excavations horizontally. Distinguished from sinking and raising. (Raymond) 2. A long narrow underground excavation or heading. 3. (Brist.) A heading driven through rock. (Gresley)

Driving cap. A cap of iron, fitted to the top of a pipe, as in an oil well, to receive the blow when driven and thus protect the pipe. (Century)

Driving on line. The keeping of a heading or breast accurately on a given course by means of a compass or transit. In Arkansas, called *Driving* on sights. (Steel)

Drop. 1. To lower the cage to receive or discharge the car when a cage of more than one deck is used. 2. (No. of Eng.). A chute down which coal is run into keels or boats. 3. To allow the upper lift of a seam of coal, to fall or drop down. (Gresley) 4. (Eng.) The quantity of coal brought down at one cutting. (Bainbridge) 5. (Scot.) The apparatus by which mineral is let down a blind shaft to a lower level. 6. (Scot.) To work the upper portion of a thick seam after the lower portion has been worked. 7. (Scot.) To stop work. (Barrowman)

Drop forge. To forge between dies by a drop hammer or drop press. (Webster)

Drop hammer. A hammer for forging, the weight being raised and then released to drop on the metal resting on the die or anvil. (Webster)

Dropper (Corn.). A branch vein leaving the main vein on the footwall side. (Raymond)

Dropping pillars and top coal (Aust.). The second working, consisting of drawing the pillars, and in thick seams breaking down the upper portion of the seam that was left temporarily in position. (Power)

Drop pit. A shaft in a mine, in which coal is lowered by a brake wheel. (Gresley)

Drop sheet (No. of Eng.). A door made of canvas, by which the ventilating current is regulated and directed through the workings (Gresley). *See also* Curtain.

Drop shot. Shot made by dropping or pouring melted lead as opposed to such as are cast, as buckshot and bullets. (Century)

Drop staple (Eng.). An interior shaft, connecting an upper and lower seam, through which coal is raised or lowered. (G. C. Greenwell)

Dropstone. A stalactitic variety of calcite. (Century)

Drop sulphur. Sulphur granulated by pouring it molten into water. (Webster)

Drop tin. Tin granulated by pouring it molten into water. (Webster)

Drop zinc. Zinc in the form of small globules. (Webster)

Dross. 1. Refuse or impurity in melted metal; slag. A zinc-and-iron alloy forming in a bath of molten zinc, in galvanizing iron. (Standard) 2. The material skimmed from the surface of freshly melted, not perfectly pure metal. (Raymond) 3. (Scot.) Small coal which passes through a riddle or screen. (Barrowman)

Dross coal. 1. (Scot.) In cannel coal districts, common or free coal. *See also* Free coal, 2 (Barrowman). 2. *See* Dross, 3.

Drossy coal (Derb.). Coal containing pyrite. (Gresley)

Drowned; Drowned out. Flooded: said of mines under water. (Gresley)

Drowned level. *See* Blind level, 2.

Drowned waste. Old workings full of water. (Gresley)

Druggon (So. Staff.). A square iron or wooden box, used for conveying fresh water for horses, etc., in a mine. (Raymond)

Drum. 1. That part of the winding machinery on which the rope or chain is coiled. (Raymond) 2. (Lanc.) A brick, iron, or wooden cylinder, used when sinking a shaft through sand. 3. *See* Running-the-drum. (Gresley) 4. A metal cask for shipment of oil, gasoline, etc.

Drum head (No. of Eng.). A short heading formed to the rise of a level, or bank head, in which the drum of a self-acting inclined plane is fixed. (Gresley)

Drum horns. Wrought-iron arms or spokes projecting beyond the surface or periphery of flat-rope drums, between which the ropes coil or lap. (Gresley)

Drumlin. An elongated or oval hill of glacial drift normally compact and unstratified, usually with its longer axis parallel to the direction of the movement of the transporting ice. (Webster)

Drumming. The process of sounding the roof of a mine to discover whether rock is loose. (Deep Vein Coal Co. *v.* Reney, 112 N. E. Rept., p. 397)

Drummy. Loose coal or rock that produces a hollow sound when tapped with any hard substance (Dodd *v.* Pocahontas Consol. Collieries Co., 244 Fed. Rept., p. 151). Said especially of a mine roof.

Drum pulley. A pulley wheel used in place of a drum (Gresley). *See also* Koepe system.

Drum rings. Cast-iron wheels, with projections, to which are bolted the staves or laggings forming the surface for the hoisting cable to wind upon. The outside rings are flanged, to prevent the cable from slipping off the drum. (Gresley)

Drum sheave (Aust.). A cylindrical drum placed vertically on the inside of a curve, against which the main rope of a main-and-tail-rope system moves when rounding the curve. (Power)

Drusa (Sp.). Druse; geode. (Lucas)

Druse. A crystallized crust lining the sides of a cavity (Raymond). *See* Geode, 1; *also* Vug.

Drusy. Covered with minute crystals.

Dry. 1. (Scot.) A joint in the roof of a coal seam, which can not usually be discovered until the roof falls. (Gresley)
2. (Scot.) An incipient crack, as in building stone. (Barrowman)
3. (Corn.) *See* Change house. 4. To free from water. 5. A drying house. 6. That which is dry, as dry land. (Webster)
7. A metal containing too large a proportion of oxygen; not sufficiently poled: said of copper in process of refining. (Standard)

Dry amalgamation. Treating ores with hot dry mercury. (C. and M. M. P.)

Dry blowing (Aust.). A method of winnowing alluvial ore by allowing it to fall from a height while the wind is blowing. (Standard)

Dry-bone. A miner's term for an earthy, friable carbonate of zinc, smithsonite. Often frequently applied to the hydrated silicate, so-called calamine. Usually found associated in veins or beds in stratified calcareous rocks accompanying sulphides of zinc, iron, and lead. (Dana)

Dry casting. A method of casting in which the molds are made of sand and afterwards dried. (Century)

Dry coal. Coal containing but little hydrogen. (Gresley)

Dry diggings. 1. Placers not subject to overflow (C. and M. M. P.)
2. Placer mines or other mining districts where water is not available. (Standard)

Dry distillation. *See* Destructive distillation.

Dryer white. A white scum which forms on brick during drying. (Ries)

Dryer. An apparatus for drying ores, preliminary to smelting. Dryers are of various types as: revolving, cylindrical, zigzag, tower, and cast-iron plates. (Ingalls, p. 617)

Dry gas. Natural gas obtained from sands that produce gas only. It does not contain oil vapors.

Dry hole. A drill hole in which no water is used, as a hole driven upward (Standard). A well in which no oil or gas is found.

Dry hone. An artificial razor hone in which the sharpening crystals or grains are so blended with the bond that good results can be obtained without the use of lubricants. (Pike)

Drying-off. The process by which an amalgam of gold is evaporated, as in gilding. (Century)

Drying oven; Porcelain oven. An oven for firing porcelain. (Standard)

Dry man. A man in charge of the building in which workmen change their clothes.

Dry method. 1. The method of mixing the raw materials of Portland cement in a dry state. (Bowles)
2. In chemical analysis, the treatment of the compound with dry reagents, as blow-piping in qualitative analysis and assaying in quantative analysis. (Standard)

Dry ore. An argentiferous ore that does not contain enough lead for smelting purposes. (C. and M. M. P.)

Dry pan. A circular revolving pan with perforated bottom, in which two large rollers revolve by friction against the pan floor. It is used for grinding dry clays. (Ries)

Dry-press process. A method of forming clay wares by using slightly moistened clay in pulverized form and pressing it into steel dies. (Ries)

Dry process. A method of treating ores by heat as in smelting; used in opposition to wet process where the ore is brought into solution before extraction of the metal. *See also* Wet process.

Dry puddling. A process of decarbonization on a siliceous hearth in which the conversion is effected rather by the flame than by the reaction of solid or fused materials. As the amount of carbon diminishes the mass becomes fusible and begins to coagulate (come to nature), after which it is worked together into lumps (puddle-balls, loups) and removed from the furnace to be hammered (shingled) or squeezed in the squeezer, which presses out the cinder, etc., and compacts the mass at welding heat, preparatory to rolling. Silicon, and phosphorus are also largely removed by puddling, passing into the cinder (Raymond). *See also* Puddling.

Dry rods (Scot.). Pump rods outside the delivery pipes or rising main. (Barrowman)

Drys. *See* Dry, 1 and 2.

Dry sand. 1. Sand prepared for molds by thorough drying and baking. When special cohesion is required (as for cores) other substances, such as flour, molasses, etc., are mixed with it. (Raymond)
2. A stratum of dry sand or sandstone encountered in well drilling. A nonproductive sandstone in oil fields.

Dry separation. The elimination of the small pieces of shale, pyrite, etc., from coal by a blast of air directed upon the screened coal. *See also* Wind method. (Gresley)

Dry sharpening stone. A stone so constituted that its crystals break away from its binding material so rapidly that the particles of steel have no chance to fill the pores of the stone. Sandstone and coarse gritted scythestones are good examples. (Pike)

Drystone. Composed of stones, not cemented with mortar, as a drystone wall. (Century)

Dry sweating. A process by which impure blister-copper is exposed to a long, oxidizing heat below fusion point. (Standard)

Dry wall. A rock wall set up without cementing material. *See* Drystone.

Dry-wall method. *See* Overhand stoping.

Dry wash. *See* Wash, 4.

D-truck (Aust.). A low side-opening truck, used for conveying coal for home consumption, and from which the coal has to be shoveled. (Power)

Dualin. A variety of dynamite consisting of 4 to 5 parts nitroglycerin, 3 parts sawdust, and 2 parts saltpeter. (Webster)

Dual rope (York.). A hemp capstan-rope upon which men ride in a mine shaft. (Gresley)

Duck machine. An arrangement of two boxes, one working within the other, for forcing air into mines. (C. and M. M. P.)

Duck's nest. *See* Springing. (Du Pont)

Duck's-nest Tuyère. A tuyère having a cupped outlet. (Standard)

Ducktownite (Tenn.). An intimate mixture of the minerals pyrite and chalcocite. (Chester)

Ductile. Capable of being permanently drawn out or hammered thin. (Webster)

Dudgeonite. The mineral annabergite with about one-third of the nickel replaced by calcium. (Min. Res., U. S. Geol. Surv., 1915, pt. 2, p. 744)

Dudley rock. A fossiliferous limestone of the English Wenlock (Upper Silurian). (Standard)

Due. The amount of royalty or ore payable to the lord of the manor or owner of the soil. (Davies)

Due bill. Same as Pay bill.

Duela (Sp.) 1. The stave of a barrel or cask, etc. 2. Stone of a floor, etc. 3. Flooring board. (Dwight)

Duefio (Mex.). Owner; shipper of ore. (Dwight)

Dues (Corn.). *See* Due. Also called Dish. (Pryce)

Duff (Aust.). The fine coal left after separating the lumps (Power). Very fine screenings; dust.

Duffer (Aust.). *See* Shicer.

Duff furnace. A furnace used for the manufacture of producer gas. (Ingalls, p. 305)

Duffy (Scot.). Soft; inferior. (Barrowman)

Dufrenite. A hydrous iron phosphate mineral. Contains approximately 27.5 per cent, P_2O_5, 62 per cent Fe_2O_3, and 10.5 per cent H_2O. Exact composition doubtful. (U. S. Geol. Surv.)

Dufrenoysite. A native sulpharsenide of lead, $Pb_2As_2S_5$. (U. S. Geol. Surv.)

Duggle (Corn.). *See* Troil

Duin. A gold-washing dish used in Jashpur, India. (Lock)

Dukeway (Som.). A method of hoisting coal on an incline from the working face to the pit-bottom by a rope attached to the winding-engine at surface in such a way that while the cage is going up, the empty trams are running down the incline, and as the cage descends the loaded cars are brought up to the shaft. (Gresley)

Dukey. 1. (Som.) A large carriage or platform mounted upon wheels and used on an inclined track underground, for carrying a number of small cars of coal. 2. (So. Wales) An inclined plane worked by engine power (Gresley). *See* Dukeway.

Dukey rider (Wales). A boy who accompanies the trams upon an incline plane. (Gresley)

Dulan (Borneo). A circular concave tray for washing gold. (Lock)

Dull. 1. (Brist.). Slack ventilation; insufficient air in a mine. (Gresley) 2. Not keen in edge or point; blunt. 3. Sluggish; slow in action. (Webster)

3. As applied to the degree of luster of minerals, means those minerals in which there is a total absence of luster, as chalk, kaolin.

Dumb bolts (Scot.). Bolts at joints of single-plated pump rods, at right angles to those through the plates, to prevent the latter from tearing the wood. (Barrowman)

Dumb'd. Choked or clogged, as a grate or sieve in which the ore is dressed. (Davies)

Dumb drift. An airway constructed to convey the ventilating current around the ventilating furnace to the upcast, instead of passing it directly through or over the fire. (Chance)

Dumb fault. A break in strata caused by a current of water eroding a portion of it during the general period of its deposition. (Power)

Dumb furnace. A ventilating furnace, designed so that the foul, inflammable air from the more remote parts of the mine enters the upcast above the hot gases from the fire. (Webster)

Dumb screw (Scot.). A screw jack. (Barrowman)

Dummy. 1. (No. Staff.) A low truck on four wheels running upon rails, and loaded with pig iron or some other heavy material; employed in steep coal beds as a balance-weight to bring up an empty tub or car. (Gresley)
2. A paper bag filled with sand, clay, etc., for tamping or for separating two charges in a double-loaded bore hole. (Du Pont)

Dumortierite. A bright smalt-blue to greenish-blue, lavender or reddish, transparent to translucent, aluminum silicate, perhaps $4Al_2O_3.3SiO_2$, occurs as a mineral, usually in fibrous to columnar aggregates. (Dana)

Dumoulin process. A method whereby copper is deposited on a rotating mandrel and later stripped off as a long strip, which is then drawn into wire without recasting. (Liddell)

Dump. 1. A pile or heap of ore, coal, culm, slate, or rock. 2. The tipple by which the cars are dumped. *See* Tipple. 3. To unload a car by tipping it up. (Chance)
4. (Cal.) The fall immediately below a hydraulic mine. (Hanks)
5. The fall available for disposal

of refuse at the mouth of a mine. (C. G. W. Lock)
6. (Eng.) A deep hole in the bed of a stream or pond. (Webster)

Dump cart. A cart or car having a body that can be tilted, or a bottom opening downward, for emptying. (Webster)

Dumper. 1. A tilting-car used on dumps. (Raymond)
2. One that dumps or operates a dump cart. (Webster)
3. (Scot.) A tool for keeping a bore hole circular. (Barrowman)

Dump hook. A chain grab hook having a lever attachment for releasing it from the object to which it is connected. (Webster)

Dump house. The building where the loaded mine cars are emptied into the chutes. (Roy)

Dump moraine. A kind of terminal moraine consisting of material dropped either from the surface or from the interior of the glacier. (Standard)

Dump-skip. A skip with an attachment that dumps the load automatically. (Standard)

Dumpy level. A surveyor's level having a short telescope rigidly fixed to a table capable only of rotary movement in a horizontal plane. (Webster)

Dune. A heap of blown sand (Roy. Com.). *See also* Sand dune.

Dunite. A variety of peridotite consisting essentially of olivine and chromite. It was named from the Dun mountains in New Zealand, the original locality, but it also occurs in North Carolina. (Kemp)

Dunn bass (Lanc.). An argillaceous shale in coal mines. *See also* Bind. (Gresley)

Dunnet shale. An oil shale, from 4 to 12 feet in thickness, found in Scotland; it yields from 24 to 33 gallons of crude oil per ton. (Bacon)

Dunn (Glouc.). Argillaceous shale. *See* Cliff, 1, and Bind, 1. (Gresley)

Dunstone. 1. (Derb.) Ironstone in beds or seams. 2. (Wales) Hard kind of fire clay, or under-clay. (Gresley)
3. A local term for certain magnesian limestones of a yellowish dun or cream color, occurring near Matlock, Derbyshire. (Page)

Dun whin (No. of Eng.). Any dun-colored, hard rock found in coal measures (Gresley). *See also* Whin.

Duplex breaker. A breaker having more than one crushing chamber. (Richards, p. 21)

Duplex channeler. A type of channeling machine which cuts two channels simultaneously. (Bowles)

Duplex hammer. *See* Double hammer.

Duplex wire. Two insulated-copper leading-wires wrapped together with paraffined cotton covering. (Du Pont)

Durangite. An orange-red fluo-arsenate of sodium and aluminium, $Na(AlF)AsO_4$, occurring in monoclinic crystals. (Dana)

Durbachite. A name given to a basic development at the outer border of a granite intrusion in Baden. It has the general composition of mica syenite. (Kemp)

Durdenite. A greenish-yellow hydrous ferric tellurite, $Fe_2(TeO_3)_3+4H_2O$. (Dana)

Dureza (Sp.). Hardness; solidity. (Halse)

Durgy (Corn.). Anything low or short. (Davies.) A variation of *durgan*, a dwarf.

Duriron. An acid-resisting alloy used in chemical works and laboratories. It consists of 14 to 14.5 per cent silicon, 0.25 to 0.85 per cent manganese, 0.2 to 0.6 per cent carbon, 0.16 to 0.2 per cent phosphorus, and under 0.05 per cent sulphur, the remainder being iron. Its melting point is from 2,500° to 2,550° F. The specific gravity is 7. (Min. and Sci. Press, vol. 114, 1917, p. 59.)

Durmiente (Mex.). A railroad-sleeper. The sill of a set of timbers. (Dwight)

Durn (Corn.). A frame of timbering, like a doorframe. (Raymond.) Also spelled Durns; Durnz; Durnze.

Duro (Sp.). Hard; *Duros* (Mex.) 1. Hard copper ores in which quartz predominates in the matrix. 2. Badly calcined ores. (Halse)

Dürr (Ger.). The barren part of a lode. (Davies)

Dust. Earth or other matter in very fine particles, so attenuated that they can be raised and carried by the wind; finely comminuted or powdered matter (Century). *See* Coal dust.

Dust bell. The seal at the bottom of the dust catcher, dust leg, or water-seal valve, which is opened periodically to drain flue dust from the system. (Willcox)

Dust chamber. An inclosed flue or chamber filled with deflectors, in which the products of combustion from an ore-roasting furnace are allowed to settle, the heavier and more valuable portion being left in the dust chamber and the volatile portions passing out through the chimney or other escape. (Century)

Dust-devil (India and Western U. S.). A moving column of sand; a sand spout (Webster). *See* Dust storm.

Duster. 1. (Wales.) A man employed in cleaning tramways of dust and dirt in and about mines. (Gresley) 2. An unproductive boring for oil or gas.

Dust explosion. An explosion of carbonaceous material as coal dust, flour, etc.

Dust firing. The burning of coal dust in the laboratory of the furnace. (Ingalls, p. 269)

Dust gold. Pieces of gold under 2 to 3 dwt. (C. and M. M. P.) Very fine gold.

Dust-laying oils. Crude oils, heavy asphalt oils, tars, solutions of petroleum asphalt in gas oils, liquid asphalt, and emulsions of oils and water, used for laying dust on roads. (Bacon)

Dustman. One who dumps the dust catcher or loads the dust at blast furnaces. (Willcox)

Dustplate. A vertical iron plate, supporting the slag runner of an iron blast furnace. (Raymond)

Dust storm. A violent, spiral convectional dust-laden whirlwind moving across an arid region (Webster). *See* Dust-devil.

Dutch drop. A haulage term used at Anaconda, Mont., for flying switch.

Dutch metal. An alloy of copper, 84.7, and zinc, 15.3 per cent. (Ure)

Dutch ocher. Chrome yellow and whiting. (Standard)

Dutch oven. *See* Forechamber.

Dutch tile. A flat enameled earthenware tile painted in colors (usually in blue) with inscriptions and designs: often used for decorating chimneypieces and fireplaces. (Standard)

Dutch white. A pigment consisting of one part of white lead and three parts of permanent white. (Webster)

Duty. 1. A measure of the effectiveness of a steam engine, usually expressed in the number of foot-pounds (or kilogrammeters) of useful work obtained from a given quantity of fuel. (Raymond)
2. (of a Cornish pumping engine) The number of pounds of water raised one foot high with a consumption of 112 lbs. of coal. (Gresley)
3. (Derb.) That part of the ore which belongs to the lord or owner of the mine, usually every thirteenth dish. *See also* Due (Hooson)

Duty-ore (Corn.). The landlord's share of the ore. (Raymond)

Duxite. A resin from the lignite of Dux, Bohemia; it fuses at 246° C., has a specific gravity of 1.133, and is near walchowite. (Bacon)

Dyas. The permian series of strata in part of western Europe, where it comprises two well-marked subdivisions. (La Forge)

Dyestone. *See* Clinton ore.

Dyestone fossil. Same as Dyestone; Fossil ore.

Dyestone ranges. A term applied to the outcrop of Clinton iron ores extending through Maryland, Virginia, West Virginia, and into Tennessee. (Ore Dep., p. 117)

Dying out. Applied to veins that gradually get narrower and narrower until they cease entirely (Power). Also called Tailing out.

Dying shift (Scot.). The third or ten o'clock shift (Barrowman). *See also* Graveyard shift.

Dyke. *See* Dike.

Dynamic geology. *See* Geology.

Dynamic head. That head of fluid which would produce statically the pressure of a moving fluid. (Standard)

Dynamic metamorphism. Metamorphism produced by earth movements in regions of great dislocation, shear or crushing of rocks. Distinguished from chemical processes, but the former are seldom unattended by the latter.

Dynamite. 1. Originally, an explosive made of 75 per cent nitroglycerin absorbed in 25 per cent kieselguhr; now any high explosive containing explosive ingredients and used for blasting purposes (Du Pont). A composition of detonating character containing nitroglycerin. "Detonating character" is used with intention, because nitroglycerin enters into the composition of mixtures which are propellants, and which are not dynamite. There are other compositions of matter containing nitroglycerin which are not dynamite, but we cannot have a dynamite which does not contain nitroglycerin. (C. E. Munroe, U. S. Bur. Mines.) The strength varies according to the percentage of nitroglycerin contained. Frequently called Giant powder.
2. To charge with dynamite. 3. To blow up or shatter with dynamite. (Webster)

Dynamiter. One who uses, or is in favor of using, dynamite or similar explosives for unlawful purposes. (Century)

Dynamo. A machine used for converting mechanical energy into electrical energy by magneto-electric induction. (Webster)

Dynamo metamorphism. Same as Dynamic metamorphism.

Dyne. In physics, the unit of force in the centimeter-gram-second system, being that force which acting on one gram for one second generates a velocity of one centimeter per second. (Century)

Dyscrasite. A variable silver antimonide mineral, including Ag_3Sb. (U. S. Geol. Surv.)

Dysodile. An inflammable, flexible, slightly elastic, yellow or greenish gray hydrocarbon from Melili, Sicily, and from certain German lignite deposits; it has a specific gravity of 1.14 to 1.25 (Bacon). When burned it yields an odor like asafoetida. (Chester)

Dysprosium. An element of the rare-earth group. Symbol, Dy; atomic weight, 162.5. (Webster)

Dystome spar. A synonym for Datolite. (Chester)

Dystomic. Having an imperfect fracture or cleavage. (Century)

Dysyntribite. A name given by C. U. Shepard, to a mineral or rock in St. Lawrence Co., N. Y., in which is a hydrated silicate of aluminium and potassium, and is related to pinite; the name means hard to crush. *Compare* Parophite. (Kemp)

Dzhu (Corn.). To cut ahead on one side of a face, so as to increase the efficiency of blasting on the remainder. (Doubtless the same word as Dissue.) *See* Dissuing. *Also* Hulk. (Raymond)

E.

Eaglestone. A concretionary nodule of ironstone of the size of a walnut or larger; aëtites. The ancients believed that the eagle transported these stones to her nest to facilitate the laying of her eggs. (Webster)

Ear. 1. The inlet or intake of a fan. (Chance)
2. (Derb.) A small iron loop or ring fixed on the sides of tubs, etc., to which side-chains are attached. (Gresley)

Earth. 1. The solid matter of the globe in distinction from water and air. The ground. The firm land of the earth's surface. 2. Loose material of the earth's surface; the disintegrated particles of solid matter in distinction from rock; soil. 3. In chemistry, a name formerly given to certain inodorous, dry, and uninflammable substances which are metallic oxides, but were formerly regarded as elementary bodies. (Century)
4. A term used for soft shaly or clayey ground when sinking through the coal measures. (Gresley)

Earth auger. An earth borer. (Standard)

Earth borer. An auger for boring into the ground. It works in a cylindrical box which retains the cut earth until the tool is withdrawn. (Standard)

Earth coal. 1. A name sometimes given to lignite. An earthy brown coal. (Gresley)
2. Mineral coal as distinguished from charcoal. (Webster)

Earth current. A current flowing through a wire the extremities of which are grounded at points on the earth differing in electrical potential. The earth current is due to this difference, which is generally temporary and often very large. (Century)

Earth din. An earth quake. (Webster)

Earth fall. A landslide. (Webster)

Earth flax. An early name for asbestos (Chester). *See also* Amianthus.

Earth foam. The mineral aphrite (Chester). A foliated pearly variety of calcite near argentine. The softer varieties approach chalk.

Earth metal. Any metal whose oxide is classed as an earth. (Webster)

Earth movement. Differential movement of the earth's crust; local elevation or subsidence of the land. (Webster)

Earth of bone (Eng.). A phosphate of lime, sometimes termed "bone phosphate," derived from bones by calcination. (Page)

Earth oil. Petroleum. (Webster)

Earth pitch. Mineral tar; a kind of asphalt. (Webster)

Earth-pulsation. A slow undulation of the earth's crust so gradual and slight as to escape ordinary observation. (Standard)

Earthquake. A local trembling, shaking, undulating, or sudden shock of the surface of the earth, sometimes accompanied by fissuring or by permanent change of level. Earthquakes are most common in volcanic regions, but often occur elsewhere. (Roy. Com.)

Earth's crust. The external part of the earth, accessible to geological investigation. The use of this term does not necessarily imply that the rest of the earth is not also solid. (Roy. Com.)

Earth-tilting. A slight movement or displacement of the surface of the ground as in some forms of earthquakes. (Century)

Earth tremor. A slight earthquake. (Standard)

Earth wax. *See* Ozocerite.

Earthy brown-coal. A brown, friable mineral, sometimes forming layers in beds of lignite. In general, it is not a true coal, for a considerable part of it is soluble in ether and benzol, and often in alcohol. *See* Leucopetrite and Bathvillite. (Bacon)

Earthy calamine. An early name for hydrozincite. (Chester)

Earthy coal. *See* Earth coal, 1.

Earthy fracture. A fracture resembling that of a lump of hard clay. (George)

Earthy lead-ore. A variety of cerussite. (Power)

Easement. An incorporeal right existing distinct from the ownership of the soil, consisting of a liberty, privilege, or use of another's land without profit or compensation; a right of way. (Standard; U. S. Min. Stat., p. 608)

Eat out (No. of Eng.). To turn a heading or holing to one side in order to mine the coal on the other side of a fault without altering the level course of the heading. (Gresley)

Eave tile; Starters. Roofing tile, closed underneath at the lower end and placed at the eave line. (Ries)

Ebano. A trade name for a residual pitch from Mexican petroleum. (Bacon)

Ebb (Scot.). Shallow, not deep (Webster). A coal seam is ebb when near the surface; the shaft is ebb which is sunk to it.

Ebb-and-flow structure. A stratification consisting of horizontally laminated layers, with others obliquely laminated, indicative of alternations of tidal currents during deposition. (Standard)

Ebonite. A black variety of hard rubber capable of being cut and polished; vulcanite. (Webster)

Eboulement (Fr.). A term adapted from the French for sudden rock falls and earth-slips in mountainous regions. (Page)

Ebullition. Act, or process of boiling or bubbling up; effervescence. (Webster)

Eccentric. A device for converting continuous circular into reciprocating rectilinear motion, consisting of a disk mounted out of center on a driving shaft, and surrounded by a collar or strap connected with a rod. Rotation of the driving shaft gives the rod a back-and-forth motion. (Standard)

Eccentric bit. A modified form of chisel used in drilling, in which one end of the cutting edge is extended further from the center of the bit than the other. The eccentric bit renders under-reaming unnecessary. It is very useful in hard rock. (Mitzakis)

Edemite; Heliophyllite. A bright yellow to green lead chlorarsenite, perhaps $Pb_4As_2O_7.2PbCl_2$, occurring as a mineral in crystal or massive form and as a incrustation. (Dana)

Echadero (Mex.). Level place near a mine, where ore is cleaned, piled, weighed, and loaded. Also called *patio* of the mine. (Dwight)

Echado (Sp.). Inclination or dip of a vein. (Halse)

Echar planilla (Mex.). Gobbing; packing; filling with waste material. (Dwight)

Eclogite. A more or less schistose metamorphic rock, consisting of a light-green pyroxene (omphacite), actinolite (var. smaragdite) and garnet. Scarcely known in America. The name is from the Greek "to select," in reference to its attractive appearance. (Kemp)

Economic geology. *See* Geology.

Economic mineral. Any mineral having a commercial value (Roy. Com.). *See also* Ore.

Economizer. An apparatus for utilizing the heat that would otherwise be wasted, as in a system of water tubes in the uptake of a boiler to heat the feed water. (Webster)

Edenite. A light-colored aluminous magnesium-calcium amphibole. A variety of the mineral hornblende. (Dana)

Edge coal; Edge seam (Eng. and Scot.). Highly inclined seams of coal, or those having a dip greater than 30°. (C. and M. M. P.)

Edge mill. A crushing or grinding *mill* for ore in which a pair of stones or metal rollers are rolled around at the ends of a horizontal shaft turning about a central vertical axis. (Webster) Also called Edge runner, and Chaser.

Edger. The long pieces of timber in a wooden pillar or crib. *See also* Crosspieces. (Sanders, p. 115)

Edge rails (Scot.). Rails of rolled iron or steel on the upper edge of which the wheels run. (Barrowman)

Edge runner. *See* Chilean mill; Edge mill; Chaser.

Edge stone (N. Y. and Pa.). A commercial term applied to bluestone that splits out in slabs thicker than flagging and suitable for curbing, sills, door caps, etc. (Bowles)

Edge water. In oil and gas wells, water that holds the oil and gas in the higher structural positions. Edge water usually encroaches on a field after much of the oil and gas has been recovered and the pressure has become greatly reduced. *Compare* Top water; Bottom water. (U. S. Geol. Surv. Bull. 658, p. 44)

Edge wheel. *See* Edge mill.

Edingtonite. A white, grayish white or pink hydrous barium and aluminum silicate mineral, perhaps $BaAl_2Si_3O_{10}+3H_2O$. (Dana)

Edisonite. Titanic acid, rutile, occurring in golden-brown, orthorhombic crystals, named in honor of Thos. A. Edison. (Chester)

Eduction pipe. The exhaust pipe from the low pressure cylinder to the condenser. (Nat. Tube Co.)

Eenie coal. (Scot.). Coal slightly altered through nearness to whin, the broken edges of which show bright circular spots more or less distinct, like eyes. (Barrowman)

Effective rate. *See* Nominal rate.

Effervesce. To bubble and hiss, as limestone on which acid is poured. (Webster)

Efficiency miner. A term frequently applied to a boss miner, or a contract miner.

Effloresce. To change on the surface, or throughout to a whitish, mealy or crystalline powder from the loss of water of crystallization on exposure to the air. (Webster)

Efflorescent. In mineralogy, forming an incrustation or deposit of grains or powder that resembles lichens or dried leaves; not uncommonly due to loss of water of crystallization. (La Forge)

Effluent. Applied by Dana to those igneous magmas which discharge from a volcano by way of a lateral fissure. *See* Superfluent and Interfluent. (Daly, p. 131)

Effluent stream. 1. A stream whose upper surface stands lower than the water table in the locality through which it flows, and which is not separated from the water table by any impervious bed. (Meinzer) 2. A stream that flows out of another stream or out of a lake. (Century)

Effosion (L.). The digging out from the earth, as of fossils, etc. (Humble)

Effusive. In petrology, poured out or erupted on the surface of the earth in a molten state, before solidification; extrusive: said of a certain class of volcanic igneous rocks. (La Forge)

Effusive period. The second and final stage of the solidification of porphyritic rocks from fusion, when at the outpouring on the earth's surface the "groundmass" is supposed to be formed. *Compare* Intratelluric period. (Standard)

Eflorescencia (Peru). An outcrop. (Dwight)

Efydd (Wales). Copper. (C. and M. M. P.)

Egg coal. In anthracite only—known as No. 2 coal. Coal that is small enough to pass through a square mesh of 2½ or 2¾ inches, but too large to pass through a mesh of 2 inches. (Chance)

Eggette. *See* Briquet.

Egg-hole. (Derb.) A notch cut in the wall of a lode to hold the end of a stempel (Raymond). A hitch.

Egg stone. Oölite. (Webster)

Eglestonite. A native mercury oxychloride, Hg_4Cl_2O. (U. S. Geol. Surv.)

Egyptian jasper. A brown jasper, found in pebbles and small bowlders in Egypt. (Chester)

Egyptian pebble. A synonym for Egyptian jasper. (Chester)

Ehrhardt powder. Any of a series of explosive mixtures containing potassium chlorate, together with tannin, powdered nutgalls, or cream of tartar, and used for blasting, shells, etc. (Webster)

Eichhorn - Liebig furnace. A hand-worked muffle furnace. (Ingalls, p. 130)

Eisener hut. The German for iron hat, or gossan. (Weed)

Eje (Sp.). 1. Axle of a wheel. 2. Axis of a fold. 3. *Ejes de cobre* (Chile), copper matte containing 40 to 60 per cent copper. (Halse)

Eleolite; Eleolite. A name formerly current for the nephelite of Pre-Tertiary rocks. It is best known in the rock-name eleolite-syenite, a synonym of nephelite-syenite, but the latter is preferable. *See* Nephelite-syenite. (Kemp)

Elastic bitumen. *See* Elaterite.

Elastic limit. That point at which the deformation in the material ceases to be proportional to the stresses. (C. M. P.)

Elastic mineral-pitch. Elaterite.

Elaterite. A massive amorphous dark-brown hydrocarbon ranging from soft and elastic to hard and brittle. It melts in a candle flame without decrepitation, has a conchoidal fracture and gives a brown streak. *See also* Wurtzilite (U. S. Geol. Surv.). Elastic bitumen.

Elbow. 1. A fitting that makes an angle between adjacent pipes. The angle is always 90 degrees, unless other angle is stated. Also called Ell. (Nat. Tube Co.)
2. An acute bend in a lode. (Skinner)

Electric air-drill. A type of tripod drill operated by compressed air supplied by a portable motor-driven compressor that accompanies the drill. (Bowles)

Electrical calamine. Zinc silicate or calamine, so called, on account of its strong pyro-electric properties and to distinguish it from Smithsonite. *See also* Calamine. (Webster)

Electrical precipitation. The removal of suspended particles from gases by the aid of electrical discharges. The electrical current used may be alternating or direct. The alternating current agglomerates the suspended particles into larger aggregates causing rapid settling, especially if the gases are quiescent. The direct current is used when large volumes of rapidly moving gas, such as occur in smelter flues, are treated. The suspended particles within a strong electric field of constant polarity become charged and are then attracted to a plate (electrode) of opposite charge. (Fulton, p. 59, Bull. 84, Bur. Mines)

Electric blasting. The firing of one or more charges electrically, whether electric blasting caps, electric squibs, or other electric igniting or exploding devices are used. (Du Pont)

Electric blasting cap. A device for detonating charges of explosives electrically. It consists essentially of a blasting cap, into the charge of which a fine platinum wire is stretched across two protruding copper wires, the whole fastened in

place by a composition sulphur plug. The heating of the platinum wire bridge by the electric current ignites the explosive charge in the cap, which in turn detonates the high explosive. (Du Pont)

Electric detonator. An electric blasting cap. (Du Pont)

Electric drill. A mechanically operated drill employing neither compressed air nor steam, but driven by electric motor. It is used chiefly in mining operations. (Bowles)

Electric exploder. A former designation for Electric blasting cap. (Du Pont)

Electric locomotive. A locomotive driven by electricity and carrying no passengers (Standard). Called also a Motor and used in mine haulage.

Electric squib. A device similar to an electric blasting cap, but containing a gunpowder composition which simply ignites but does not detonate an explosive charge; used for electric firing of blasting powder. (Du Pont)

Electric system. All electric apparatus pertaining to the operation of the mine, and under the control of the mine officials, that is connected electrically to a common source of potential or that is installed so that it can be thus connected. (Clark)

Electric welding. A process of welding in which the parts to be joined are heated to fusion by an electric arc (arc welding) or by the passage of a large current through the junction; used in uniting steel rails, tubing, etc. *See also* Thermite. (Webster)

Electrobronze. Electroplated with bronze. (Standard)

Electrochemistry. The branch of chemistry that treats of electricity as active in effecting chemical changes. (Standard)

Electrocopper. To plate or cover with copper by means of electricity. (Century)

Electrode. Either terminal of an electric source; either of the conductors by which the current enters and leaves an electrolyte. *See* Anode; *also* Cathode. (Webster)

Electrolysis. Act or process of chemical decomposition by the action of an electric current; subjection to this process, as the electrolysis of salts of silica or nickel. (Webster)

Electrolyte. 1. The solution in which electrolytic separation of metals is carried on. (Weed)
2. A chemical compound which can be decomposed by an electric current. (Standard)

Electrolytic. Pertaining to electrolysis or an electrolyte; deposited by electrolysis (Webster). As applied to copper, means copper made from impure metal by electrical decomposition and redeposition; the bar of impure copper is gradually dissolved and the pure metal redeposited at the opposite pole of the battery, while other metals fall as black slime to the bottom of the tank in which the solution (electrolyte) is held. (Weed)

Electrolytic copper. The purest grade of refined copper, produced by the electrolytic process, and possessing the highest electric conductivity. (Skinner)

Electrolytic process. A process employing the electric current, either for separating and depositing metals from solution, or as a source of heat in smelting, refining, etc. (Standard). The process has many modifications and is used for recovering metals, as tin from scrap, or refining as of copper for electroplating, recovering metal from ore as by a combination of leaching, and electrolytic deposition.

Electrolyze. To subject to electrolysis. (Webster)

Electrometallurgy. That department of metallurgy employing the electric current, either for the electrolytic separation and deposition of metals from solutions, or as a source of heat in smelting, refining, etc. (Webster)

Electromotive force. The force, which by reason of differences of potential, causes electricity to move along a conductor.

Electron. One of those particles, having about one-thousandth the mass of a hydrogen atom, which are projected from the cathode of a vacuum tube as the *cathode* rays, and from the radioactive substances as the *beta* rays; also called Corpuscle. (Webster)

Electroplate. To plate or cover with an adherent coating of metal, commonly silver, nickel, or gold, by electrolysis. (Webster)

Electrum. 1. A natural alloy of gold and silver containing approximately 40 per cent of silver. (U. S. Geol. Surv.)
2. An alloy of copper, zinc, and nickel (Raymond). *See also* German silver.
3. *See* Succinite; *also* Amber.

Element. One of a limited number of distinct varieties of matter which, singly or in combination, compose every material substance; a substance which can not be separated into substances different from itself, at least by ordinary chemical processes. (Webster)

Elevante (Mex.). An overhand stope. (Dwight)

Elevator. 1. A device for raising or lowering tubing, casing, or drive pipe, from or into well. *See* Casing elevator. (Nat. Tube Co.)
2. A mechanical contrivance usually an endless belt or chain with a series of scoops or buckets for transferring material, as grain, to an upper loft or bin for storage.
3. A cage or platform and its hoisting machinery in a warehouse, mine, etc., for conveying persons or goods from one level or floor to another. Called a Lift in England. (Webster)

Elevator pump. An endless band with buckets attached, running over two drums for draining shallow ground. (C. and M. M. P.)

Elevator rope. A rope used to operate an elevator. (C. M. P.)

Elie ruby (Eng.). A variety of pyrope found in small garnet-like grains in the trap-tuff of Kincraig Point, near Elie, in Fifeshire. (Page)

Elihu Thomson process. A method of electric welding of iron. (Goesel, p. 110)

Eliquate. 1. To liquate; smelt. 2. To part by liquation. (Webster)

Eliquation. *See* Liquation.

Ellis vanner. A gyratory vanner.

Elmore process. 1. (Old Process) A flotation process wherein the ore is mixed with several times its weight of water, and an equal, or greater weight of oil. The oil carries the sulphides to the surface, and the gangue and water are removed from the bottom. This process was invented in 1898. 2. (Vacuum Process) A flotation process invented by Francis E. Elmore in 1904 in which flotation is secured by the addition of a small quantity of oil, and by the liberation of air in the pulp in a finely divided condition, this being accomplished by subjecting the freely flowing pulp to a vacuum and simultaneous heating. (Liddell)

Elpasolite. A variety of cryolite, in which the sodium is partly replaced by potassium. (Standard)

Elutriate. To cleanse or wash, or purify by washing and straining or decanting. (Webster)

Elutriation. Purification by washing and pouring off the lighter matter suspended in water, leaving the heavier portions behind. (Raymond)

Eluvial. Formed by the rotting of rock in place to a greater or less depth. (U. S. Geol. Surv. Bull. 263, p. 26)

Eluvium. Atmospheric accumulations *in situ*, or at least only shifted by wind, in distinction to alluvium, which requires the action of water. (Power)

Elvan. The Cornish name for a dike of quartz-porphyry or of granite-porphyry. (Kemp)

Elvan course. A plutonic dike (Duryee). An Elvan dike.

Elvanite (Corn.). A variety of rock of which elvans are made up, nearly equivalent to quartz-porphyry and granite-porphyry. (Century)

Elve. The handle of a miner's pick (Milford). A variation of Helve.

Embanques (Mex.). The wall accretions of a water-jacket furnace. (Halse)

Embarcarse la veta (Peru). To be lost (as a vein) by reason of a fault or intersecting dike. (Dwight)

Embayment. A deep depression in a shore line forming a large open bay. (Lowe)

Embije (Mex.). Thinly laminated mineral structure. (Dwight)

Embolite. A chlorobromide silver mineral, Ag(Cl,Br). (U. S. Geol. Surv.)

Emborrascarse (Mex.). To become barren by pinching out, etc. (Dwight)

Embouchure (Fr.). The mouth of a river. (Webster)

Embozado (Mex.). Rich mineral entirely embedded and concealed in barren rock. (Dwight)

Embudo (Mex.). A funnel; hopper. (Dwight)

Emerald. A bright, emerald-green, variety of beryl. Used as a gem. Called *Canutillos* in South America. (Dana)

Emerald copper. Same as Dioptase.

Emerald nickel. *See* Zaratite.

Emerged bog. In geology, a bog which grows high above the water-level, drawing up the water by its sponginess, and becoming much thicker than an immersed bog (Standard). *Compare* Immersed bog.

Emery. An impure form of the mineral corundum (Al_2O_3) used as an abrasive. *See* Corundum. (U. S. Geol. Surv.)

Emery stone. A mixture of gum shellac and emery, or emery and clay used for emery wheels. (Century)

Emery wheel. A wheel coated with emery or made of emery stone: for grinding or polishing. (Standard)

Emmonite. A variety of strontianite in which the strontium is partially replaced by calcium. (Standard)

Emmonsite. Probably a hydrated ferric tellurite. In thin yellow green scales. (Dana)

Empalado (Sp. Am.). Timbering; propping. (Lucas)

Empalmar (Sp.). To splice; to join. (Dwight)

Empalme (Sp.). 1. Splice in a rope. 2. Timber joint. 3. Junction of roads. (Dwight)

Emparejar (Sp.). To level or square up. (Halse)

Empellar (Mex.). To add silver or copper amalgam in the *patio* process. (Halse)

Empirical. Pertaining to or derived from experience or experiments, as an empirical formula.

Empleo (Sp.). The quantity of quicksilver mixed with the ore on any given occasion for effecting the amalgamation. (Min. Jour.)

Emplomada (Sp.). Lead poisoning. (Halse)

Empties. Empty mine or railroad cars. Empty railroad cars are called "flats" in Arkansas. (Steel)

Empty rope. Any winding or hauling rope from which the load upon it has been removed. (Gresley)

Empty track. A track for storing empty mine cars. (Steel)

Empty trip. Empty coal cars returning for another load. (Hargis)

Empyrical. (Rare) 1. Of or pertaining to combustion. 2. Having a combustible principle, as coal. (Standard)

Ems method. The condensation of dust and fumes from calcining furnaces by use of large flues filled with parallel rows of sheet iron. (Trans. Am. Inst. Min. Eng., vol. 11, p. 379)

Emulsion. Milkification. A liquid mixture in which a fatty or resincus substance is suspended in minute particles almost equivalent to molecular dispersion. From *L. emulgeo*, to drain out, in turn from *e.* out, and *mulgeo*, milk. (Rickard) A combination of water and oily material made miscible with water through the action of a saponifying or other agent. (Bacon)

Enajenada (Mex.). A change of ownership. (Dwight)

Enameled brick. Bricks which are coated on one or more surfaces with a white or colored enamel. (Ries)

Enamel kiln. A kiln for enameling porcelain. (Standard)

Enantiomorphous. Similar in form but not superposable. Said of certain hemihedral crystals. (Webster)

Enargite. A copper sulpharsenide mineral, Cu_3AsS_4. Contains 48.4 per cent copper. (U. S. Geol. Surv.)

En bonanza (Sp. Am.). Said of a mine when it is being worked at a profit. (Halse)

Encampanado (Mex.). A shaft which does not reach the lower level of the mine. (Dwight)

Encampane (Peru). The difference of level between any gallery and the surface. (Halse)

Encapillar (Mex.). To start work in a new gallery. (Dwight)

Encargado (Mex.). A superintendent. (Dwight)

Encaustic tile. Floor tile having a surface pattern of one type of clay and backing of a different one. (Ries)

Enchada (Braz.). A kind of hoe used by gold washers. (Halse)

Encierro (Sp. Am.). Configuration of country which has arrested the flow of water and caused it to deposit auriferous alluvion. (Lucas)

Encina (Sp.). Oak; *E. blanca*, white oak; *E. negra*, black oak. (Dwight)

Encosta (Braz.). Hillsides on which alluvial benches are found. (Halse)

Encroachment (Scot.). Trespass; the area beyond the boundary from which mineral has been abstracted. (Barrowman)

Encubado (Sp.). Tubbing. (Halse)

Encuentro (Sp.). 1. Meeting of two galleries. 2. Meeting another vein that intersects the one on which work is being done. (Halse)

End. 1. (Scot.) A room or working place facing the ends or secondary joints of a seam, *i. e.*, in the line of the main joints (Barrowman). Also called Butt.
2. (Eng.) The inner extremity of a heading or stall. (Gresley)

End bands. Half tile, made by cutting whole tile longitudinally, and used where the roof butts against a vertical surface. (Ries)

End-bump table. A mechanically operated, sloping table by which heavy and light minerals are separated. The end motion imparted to the table tends to drive all minerals up the slope of the table, but a flow of water carries the quartz and other light minerals down faster than the mechanical motion carries them up. The heavy minerals settle to the bottom and finally reach the upper end and are delivered into a proper receptacle. The Gilpin County, Imlay and Golden Gate concentrators are the chief types.

End course; On-end (Scot.). At right angles to, or facing, the end joints. (Barrowman)

Ending (Eng.). An adit driven in a direction with the grain of the coal. (Bainbridge)

End joint; End cleat; Butt cleat. A joint or cleat in a seam about at right angles to the principal or face cleats. (C. and M. M. P.)

Endless-chain haulage. *See* Endless-rope haulage.

Endless-rope haulage. A haulage system using an endless traction rope or chain for transporting cars, either on surface or underground tramways.

Endlichite. A variety of the mineral vanadinite in which the vanadium is partly replaced by arsenic. (Dana)

End lines. The boundary lines of a mining claim which cross the general course of the vein at the surface. If the side lines cross the course of the vein instead of running parallel with it, they then constitute end lines. (King *v.* Amy etc., Co., 152 United States, p. 228; Last Chance Mining Co. *v.* Tyler Mining Co., 157 United States, p. 696)

When a mining claim crosses the course of the lode or vein instead of being along such lode or vein, the end lines are those which measure the width of the claim as it crosses the lode. (Argentine Mining Co. *v.* Terrible Mining Co., 122 United States, p. 485; U. S. Min. Stat., pp. 145–150)

End of coal. The direction, or section, at right angles to the face; sometimes called the butt. (Raymond)

Endomorph. A crystal of one species inclosed within one of another, as one of rutile in quartz. (Webster)

Endomorphic. Pertaining to, or characteristic of contact metamorphism that takes place within the cooling eruptive rock; resulting from the reaction of the wall rock upon the peripheral portion of an eruptive rock mass. (La Forge)

End-on. Working a seam of coal, etc., at right angles to the cleat, or natural planes of cleavage. (Gresley)

Endosmosis. The transmission of a fluid inward through a porous septum or partition which separates it from another fluid of different density. Opposed to Exosmosis. (Century)

Endosmotic. Of, or pertaining to the flow or diffusion of water or solutions through the invisible pores of a rock inward to fissures. (Power)

Endothermic. Pertaining to a chemical reaction which occurs with absorption of heat. (Webster)

End piece (Corn.). *See* Wall plates.

End plate. *See* Side plates. In timbering, where both a cap and a sill are used, and posts act as dividers, the posts become the end plates. (Sanders, p. 10)

Ends (York). Headings which are driven on the end or end-on. (Gresley)

Enfriar (Mex.). To add to the *torta* substances which reduce cupric to cuprous salts. (Dwight)

En frutos (Sp.). Producing ore. (Halse)

Enganchador. 1. (Sp.) An on-setter. A hooker-on, bottomer. 2. (Peru) An agent who furnishes mine labor on contract. (Halse)

Enganchar. 1. (Sp.) To fasten or hook on the bucket, kibble, etc. 2. (Peru) To engage miners. (Halse)

Engache (Sp.). Attaching cars, wagons, etc. to haulage or hoisting ropes or chains. (Halse)

Engine. 1. Any of numerous machines by which physical power is applied to produce a desired physical effect, especially one for converting a physical force, as heat, into mechanical power. (Webster)
2. (Eng.). A collier's term for engine-house or building, arching, etc., within which a steam engine is fixed. (Gresley)

Engine barrel (Scot.). A large water barrel used in sinking shafts. (Barrowman)

Engineer. 1. One versed in any branch of engineering, as a civil, mining or electrical engineer, and who applies creative effort to the solution of problems. 2. One who carries through an enterprise by skillful or artful contrivances; an efficient manager. 3. Any one who manages or runs any stationary engine or locomotive; an engine driver. The term engineman is used by the U. S. Department of Labor in preference to engineer, the latter being defined as under 1, above.

Engine keeper (Scot.). A brakeman. (Gresley)

Engineman (Eng.). One who works a winding, hauling, fan, pumping or other engine. (Gresley). *See* Engineer, 3.

Engine pit (Eng. and Scot.). A shaft used entirely for pumping purposes. (Gresley)

Engine plane. 1. (Eng.) An underground way, either level or dipping inbye or outbye, or both (undulating), along which the cars are conveyed to and from the workings by engine power. *See* Endless chain; Endless rope; Main rope; Tail rope. (Gresley)
2. A passageway having a steep grade along which cars are raised and lowered by a rope attached to an engine; a plane. In Arkansas, limited to planes down which coal is lowered. When the coal is hoisted, the plane is known as a slope. (Steel)

Engine road (Scot.). A haulage road worked by engine power. (Barrowman)

Engine seat (Scot.). The platform or foundation to which an engine is fastened. (Barrowman)

Engine shaft. Usually the principal shaft in a mine, and the one at which the hoisting and pumping are done. (Roy. Com.)

Engine tenter (No. Staff.). A brakeman. (Gresley)

Enginewright (Mid.). A practical man, whose duty about a colliery is to inspect the machinery, ropes, and other appliances. (Gresley)

Englacial. Embedded in a glacier, as englacial drift; also traversing the body of a glacier, as an englacial stream. (Webster)

Englacial-till. *See* Till.

English cupellation. A method of refining silver in which the characteristics are: A small reverberatory furnace with a movable bed and a fixed roof, and the fact that the bullion to be cupelled is charged gradually and the silver refined in the same furnace where the cupellation is carried on. (Hofman, p. 518)

English furnace. A small furnace for the distillation of zinc. The English furnaces differ from other types by distilling the zinc *per descensum* instead of *per ascensum*. (Ingalls, p. 390)

English method. A method of smelting lead ore in which the characteristics are: A large charge of lead ore, a quick roasting, a high temperature throughout and the aim to extract all the lead in the reverberatory. The hearth inclines toward the middle of one of the sides, the lead collects in the furnace and is tapped at intervals into an outside kettle. (Hofman, p. 95)

English process. In copper smelting, the process of reduction in a reverberatory furnace, after roasting, if necessary. (Raymond)

English salts. Epsom salts. (Webster)

English zinc-furnace. A furnace in which zinc is reduced and distilled from calcined ores in crucibles. (Raymond)

Engorgement. The clogging of a furnace. *See also* Scaffold, 2. (Raymond)

Engranar (Sp.). To throw into gear. (Dwight)

Engrasadura (Mex.). A grease-cup. (Dwight)

Enhydrite. A mineral (as nodules of chalcedony) having cavities containing water. (Standard)

Enhydrous. Containing water; having drops of included fluid; as, enhydrous chalcedony. (Standard)

Enjalma (Sp.). A kind of pack saddle. (Halse)

Enmaderado (Sp.). Timbering; casing. (Lucas)

Enrichment. The action of natural agencies which increases the metallic content of an ore. Secondary sulphide enrichment refers to the formation of new sulphide minerals which contain a larger percentage of the metals. (Farrell)

Enriquecimiento (Sp.). Enrichment of veins. (Halse)

Enrockment. A mass of large stones thrown into water to form a base, as for piers, breakwaters, etc. (Webster)

Ensalmorar (Mex.). To add salt. (Halse)

Ensalmoro (Mex.). The addition of salt to the *torta*. (Dwight)

Ensanchar (Sp.). 1. To enlarge a bore hole. 2. (Colom.) *E. el hilo*, to cut down the soft wall of a lode for the purpose of widening a drift. (Halse)

Ensancharse (Mex.). The widening of a vein. (Dwight)

Ensayador (Sp.). An assayer. (Dwight)

Ensayar (Sp.). To assay. (Dwight)

Ensaye (Sp.). 1. Assay. 2. Assay office (Dwight)
3. In gold washing, a trial made by a pan. In the *patio* process a test of the *torta*. (Halse)

Enstatite. 1. A magnesium silicate mineral, $MgSiO_3$. (Dana) 2. The variety of orthorhombic pyroxene with less than 5 per cent FeO. It is largely used as a prefix to the names of rocks that contain the mineral. (Kemp)

Entblössen (Ger.). Uncovering a lode. (Davies)

Entibación (Sp.). Timbering of mines; walling. (Lucas)

Entibador (Sp.). A timberman. (Halse)

Entibar (Sp.). To timber a mine or any part thereof. (C. and M. M. P.)

Entibo (Sp.). A prop or stay. (Halse)

Entoölitic. Oölitic structure formed by filling small globular spaces after the manner of a secretion. Opposed to Extoölitic. (Power)

Entrada (Sp.). Entrance to a mine. (Halse)

Entresuelo (Mex.). Gallery between two levels (Dwight). An intermediate level.

Entromparse (Mex.). To form a "nose" of slag in the blast furnace. (Halse)

Entry. 1. In coal mining a haulage road, gangway, or airway to the surface. 2. An underground passage used for haulage or ventilation, or as a manway. *Back entry*, the air course parallel to and below an entry. Distinguished from *straight entry*, *front entry*, or *main entry*. *Dip entry*, an entry driven down hill so that water will stand at the face. If it is driven directly down a steep dip it becomes a *slope*. *Gob entry*, a wide entry with a heap of refuse or gob along one side. *Slab entry*, an entry which is widened or *slabbed* to provide a working place for a second miner. *Double-entry*, a system of opening a mine by two parallel entries; the air current is brought into the rooms through one entry and out through the parallel entry or air course. *Cut-off-entry*, an entry driven to intersect another and furnish a more convenient outlet for the coal. *Single entry*, a system of opening a mine by driving a single entry only, in place of a pair of entries. The air current returns along the face of the rooms, which must be kept open. *Triple-entry*, a system of opening a mine by driving three parallel entries for the main

entries. *Twin-entry*, a pair of entries close together and carrying the air current in and out, so laid out that rooms can be worked from both entries. Also called Double entry. (Steel)
3. (Scot.) The beginning of a lease. (Barrowman)

Entryman. 1. A miner who works in an entry. (Steel)
2. One who enters upon public land with intent to secure an allotment under homestead, mining, or other laws. (Webster)

Entry stumps. Pillars of coal left in the mouths of abandoned rooms to support the road, entry, or gangway until the entry pillars are drawn. In Arkansas these pillars are called Entry stumps even when the rooms are first driven, before any pillars are pulled or the rooms abandoned. (Steel)

Entuar (Colom.). To overfeed a stamp mill. (Halse)

Envainado (Mex.). Lost or left to one side (as a vein). (Dwight)

Eo. In geology, indicating the dawn or earliest phase of an epoch, as Eocene. (Standard)

Eocene. In the usage of the U. S. Geological Survey, the earliest of the epochs into which the Tertiary period is divided; also the series of strata deposited at that time. (La Forge)

Eolation. The process by which wind modifies land surfaces, both directly by transportation of dust and sand, and by the work of sand blasts, and indirectly by wave action on shores; eolic gradation. (Standard)

Eolian. (Formerly spelled aeolian.) Of, relating to, formed by, or deposited from the wind or currents of air. (La Forge)

Eolian marble. A name given by Hitchcock to the crystalline granular limestones of Mount Eolus, in Vermont. (Merrill)

Eon; Aeon. A period of existence; an age; an infinite space of time. The term is used by some geologists to denote any one of the grand divisions of geological time. (Webster)

Eopaleozoic. The earlier portion of Paleozoic time, including the Cambric and the siluric. (Standard)

Eorhyolite; Eobasalt; etc. A series of names proposed by O. Nordenskjoeld for the older equivalents of the rhyolites, basalts, etc. The terms are practically equivalent to aporhyolite, apobasalt, etc., but the latter have priority. (Kemp)

Eozoic. Pre-Cambrian; pre-Paleozoic. Formerly applied to the rocks now included in the Archean and Algonkian systems and the corresponding geologic periods, being intended to supplant Azoic when it was learned that the Azoic rocks contain some fossil remains. (La Forge)

Epeirogenic. Of, or pertaining to, causing, or designating the rising or sinking of extensive tracts of the earth's crust. (Webster)

Epeirogeny. The deformation of the crust of the earth by which the broader features of relief, such as continents, ocean basins, and the greater plateaus, are formed. *See* Diastrophism. (Webster)

Ephemeral stream. A stream which flows in direct response to precipitation. (Meinzer)

Ephemeris. A publication giving the computed places of the heavenly bodies for each day of the year, with other numerical data (Webster). An astronomical almanac.

Epicenter. That part of the earth's surface directly above the origin of an earthquake. (La Forge)

Epiclastic. Consisting of the consolidated detritus of preëxistent rocks. (Standard)

Epicontinental. Situated upon a continental plateau or platform, as an epicontinental sea. (La Forge)

Epicrystalline. Both sedimentary and crystalline in character: said of strata. (Standard)

Epidiabase. A name proposed by Issel as a substitute for epidiorite because believed to be more appropriate. (Kemp)

Epidiorite. A name applied to dikes of diabase, whose augite is in part altered to green hornblende. The name was coined before it was understood that the hornblende was secondary in this way. It was first applied by Gümbel in 1879 to a series of narrow dikes that cut Cambrian and Ordovician strata in the Fichtelgebirge. The name emphasizes their age as later than the typical pre-Cambrian diorites, but its significance has been expanded in later years. (Kemp)

Epidosite. Rocks largely formed of epidote. The epidote seems generally to be produced by the reactions of feldspar and bisilicates upon each other during alteration. (Kemp)

Epidote. A basic orthosilicate of calcium, aluminum, and iron, $H_2O.4CaO.3(Al,Fe)_2O_3.6SiO_2$ (U. S. Geol. Surv.). The name of this mineral is often prefixed to the names of rocks containing it. As a rule, the presence of epidote indicates the advance of alteration. (Kemp)

Epidotization. The production of epidote in a rock by metamorphism. (Webster)

Epigene. 1. Formed, originating, or taking place on the surface of the earth. 2. Foreign. Said of forms of crystals not natural to the substances in which they are found. *Compare* Pseudomorph. (Webster)

Epigenesis. Change of the mineral character of a rock due to outside influences. *Compare* Metamorphism (Webster). As applied to ore deposits, *epigenetic* deposits are younger than the country rock containing them. (Vogt)

Epiphesis. *See* Apophysis.

Epoch. Generally, that part of geologic time during which a formation or group of strata was deposited: used by the U. S. Geological Survey indifferently as the time equivalent of a series or a group, but restricted by the International Congress to a division of a period, hence the time equivalent of a series. (La Forge)

Epsomite. A mineral composed of hydrous magnesium sulphate, $MgSO_4+7H_2O$. (U. S. Geol. Surv.)

Epsom salt. Same as Epsomite.

Equivalent. 1. In geology corresponding in geologic age or stratigraphic position; said of formations, etc. (La Forge)
2. A term applied to grains of ore or vein-stuff of varying diameters and density, which fall through water at an equal velocity (Hunt). Usually used in the plural.

Era. In geology, in general a large division of geologic time; specifically, a division of geologic time of the highest order, comprising one or more periods. The eras now generally recognized are the Archeozoic, Proterozoic, Paleozoic, Mesozoic, and Cenozoic. (La Forge)

Erbhefste (Ger.) The deepest part of a mine. (Davies)

Erbium. A metallic element of the rare earth group. Symbol, Er; atomic weight 167.7. (Webster)

Erg. The amount of work done by one dyne working through a distance of one centimeter. One foot-pound is equal to 13,560,000 ergs. (Webster)

Erlan; Erlanfels. A name proposed by Breithaupt for metamorphic rocks, which consist essentially of augite, *i. e.*, augite schists. The name is derived from the iron furnace at Erla, near Crandorf, Saxony. (Kemp)

Erles (Eng.). Earnest money. (Bainbridge)

Erodible. Yielding more or less easily to erosive action; as, underlying easily erodible limestones. (Standard)

Erosion. The group of processes whereby earthy or rock material is loosened or dissolved and removed from any part of the earth's surface. It includes the processes of weathering, solution, corrasion, and transportation. The mechanical wear and transportation are effected by running water, waves, moving ice, or winds, which use rock fragments to pound or grind other rocks to powder or sand. (Ransome)

Erosion surface. A land surface shaped by the disintegrating, dissolving, and wearing action of streams, ice, rain, winds, and other land and atmospheric agencies. (Ransome)

Erosive. 1. Having the property of eating away or corroding; corrosive. 2. Wearing away; acting by erosion. (Century)

Erratic. A name often given to transported bowlders (Roy. Com.). Loose gravel and stones on the earth's surface, including what is called drift. (Webster)

Erratic blocks (Eng.). *See* Erratic. Rounded erratic blocks are called bowlders.

Erubescite. A synonym for Bornite. (A. F. Rogers)

Eruption. In geology, the emission or ejection, at the earth's surface, through a crater, pipe, or fissure, of such material as lava, heated water, gases, mud, stones, and dust; characteristic of volcanoes and geysers and usually more or less sudden, violent, and explosive. (La Forge)

Eruptive. The name given to rocks that have burst through other rocks in a molten state, or that have been thrust up bodily (Davies). The name ought properly to be only applied to effusive or volcanic rocks, but it is often used as a synonym for igneous. (Kemp)

Eruptive vein. A vein filled by eruption of igneous matter from below. (Standard)

Erythrite; Cobalt bloom. A hydrous cobalt arsenate. $Co_3As_2O_8.8H_2O$. Found in the oxidized parts of cobalt and arsenic-bearing veins. (U. S. Geol. Surv.)

Escala (Sp.). 1. Ladder. 2. *E. movil*, a man engine. 3. In drafting, a scale. (Halse)

Escalera (Mex.). A ladder, generally made of notched poles; *E. de barrotes*, mine ladder with rounds; *E. de muescas*, mine ladder or notched timber. (Dwight)

Escalón (Sp.). 1. A step, round, or rung. 2. A stope; *E. de banco*, an underhand stope; *E. de cielo*, an overhand stope. 3. Scale. (Halse)

Escantillón (Mex.). A wooden ruler used by timbermen; pattern; gage. (Dwight)

Escape (Eng.). A second or additional shaft by which the men may get out of the mine in case of accident to the other shafts. Also an Upcast; Escape pit; Escape way. (Gresley)

Escape way. An opening through which the miners may leave the mine if the ordinary exit is obstructed. (Steel)

Escar. *See* Esker.

Escarcha (Peru). Native silver in thin plates. (Dwight)

Escarpment. A cliff or relatively steep slope separating level or gently sloping tracts. (La Forge)

Eschka's mixture. Magnesium oxide and sodium carbonate. (Liddell)

Escogedor (Braz. and Colom.). An ore picker or sorter. (Halse)

Escoger (Sp.). To pick or sort ore. (Halse)

Escombrera (Sp.). A place where waste from the mine is thrown; a dump. (Halse)

Escombros. 1. (Fr. Guiana). In placer mining, an overburden of red and yellow variegated clays containing pebbles. (Halse)
2. (Mex.). Waste rock. (Dwight)

Escoria (Sp.). 1. Slag or cinders. 2. A spongy lava. (Halse)

Escorial. 1. (Sp.-Am.). A pile or dump of slag, or a yard containing such dumps. (Webster)
2. An exhausted mine. (Standard)

Escorificador (Mex.). Scorifier, in assaying. (Dwight)

Escritura (Sp.). A deed, instrument, bond, or contract. (Halse)

Escrow. A deed, bond, or other written engagement, delivered to a third person to be delivered by him to the grantee only upon the performance or fulfillment of some condition. (Webster)

Escuadra (Mex.). A change of direction of 90°; square. (Dwight)

Escuela de minas (Sp.). A school of mines. (Halse)

Escurrir (Sp.). To leak; to drip; to drain off. (Dwight)

Esker; Escar; Eskar. A narrow ridge of gravelly or sandy drift, deposited by a stream in association with glacier ice. Eskers were formerly called Serpentine kames. (Webster)

Eslabón (Mex.). A link of a chain. (Dwight)

Esmanil (Sp.). Blende. (Halse)

Esmeralda (Sp.). Emerald. (Dwight)

Esmeril (Sp.) Emery. (Dwight)

Espato (Sp.). Spar; *E. fluor*, fluorspar, bluejohn; *E. calizo*, calcite; *E. de hierro*, siderite; *E. de Islandia*, Iceland spar; *E. de manganeso*, rhodocrosite; *E. pesado*, heavy spar; barite. (Halse)

Espátula (Sp.). Spatula. (Dwight)

Espejado (Peru). Galena. (Dwight)

Espejo (Colom.). A slickenside. (Halse)

Espejuelo (Sp.). 1. A transparent piece of talc. 2. Mica. 3. Selenite. 4. (Mex. and Chile) Calcite. 5. (Hid., Mex.) Galena in large crystals, also blende in large crystals. 6. (Mex.) A slickenside. 7. (Peru) Barite. (Halse)
8. (Peru) Lead carbonate mixed with galena and gray copper. (Dwight)
9. (Mex.) A mineral gangue, with a faintly reflecting surface. (C. and M. M. P.)

Espeque (Mex.). A handspike; wooden lever; the long arm or lever in machinery moved by animal power. (Dwight)

Esperanza classifier. A classifier of the free-settling type in which the settled material is removed by dragging it up an inclined plane by means of a continuous belt of flat blades or paddles. It is continuous in its operation. (Liddell)

Espesor (Sp.). Thickness of a vein or bed. (Halse)

Espetón (Mex.). The tapping bar of a smelting furnace. (Dwight)

Espinguetta (Sp.). A blasting needle. (Halse)

Espoleta (Mex.). The blasting charge for a small blast; primer or blasting fuse. (Dwight)

Esponja. 1. (Mex.) Spongy bullion, after retorting and before melting. (Dwight)
2. (Sp.) A network of narrow ferruginous veins. (Halse)

Esporton (Sp.). A large basket (Halse). *See also* Espuerta.

Espuela (Mex.). Additional quantity of copper sulphate required in the *torta*, when not enough was added at first. (Dwight)

Espuerta (Spain). A large basket attached to an endless wire rope for removing sulphur from the mines. The baskets are 10 to 12 feet apart. (Halse)

Espuma (Sp.). 1. Scum, froth, foam. 2. Gossan. 3. Magnesia. 4, Dross of metals. 5. (Colom.) *Oro de E.*, float gold. (Halse)

Esquisto (Sp.). Shale; schist or slate. (Halse)

Essential. In petrology, necessarily present in any variety of rock, being required by the definition of the variety: said of some minerals in a rock. (La Forge)

Essexite. A name derived from Essex County, Mass., and applied to a granular igneous rock intermediate between the nephelite-syenites, the diorites, and the gabbros, which contain labradorite, orthoclase, and more or less nephelite or sodalite, together with augite, biotite, barkevicite, olivine, and apatite. (Kemp)

Essonite. A cinnamon-colored variety of garnet; called hyacinth when used as a gem, though the term more properly belongs to zircon. (U. S. Geol. Surv.)

Estaca (Sp.). 1. A stake. *E. fija*, a post driven into the ground from which the mining claim was originally measured. 2. *Estacas*, divisions or partitions made in mines. 3. (Colom.) A person who works a mine solely to retain title; the owner of a mine who pays the tax but does not work it. 4. Lagging. (Halse)

Estacada (Mex.). The lagging of the sides of a shaft in open-crib timbering. (Halse)

Estacar (Sp.). To stake out a claim, road, etc. (Halse)

Estación. 1. (Sp.) A surveyor's station or point. 2. (Colom.) A length of 100 feet in lining out a railroad. 3. Season (of the year). (Halse)

Estadia (Mex.). A leveling rod. (Dwight)

Estado (Peru). A measure of length (2⅔ *varas*). Approximately a fathom. (Dwight)

Estalactita (Sp.). A stalactite. (Dwight)

Estalagmita (Sp.). A stalagmite. (Dwight)

Estampillas (Mex.). Stamps with which the Government taxes are paid; postage stamps. (Dwight)

Esthanho (Port.). Tin. (Halse)

Estaño (Sp.) 1. Tin. 2. Tin ore as cassiterite; *E. de grano, E. de placeres*, stream tin. 3. Tin concentrate. *See* Barrilla, 3. 4. *E. de escoria*, slag tin. (Halse)

Estanque (Mex.). A tank; reservoir. (Dwight)

Este; Oriente (Sp.). East. (Dwight)

Esteatita (Sp.). Steatite or soapstone. (Halse)

Esteos (Mex.). Vertical beams supporting the pulley of a hoist. (Dwight)

Estereis (Braz.). 1. Veinstone; mattrix. 2. Barren rock. (Halse)

Esterellite. A name given by A. Michel-Levy to a variety of diorite-porphyry from Esterel, France. The rock shows some peculiarities of chemical composition which have given it special interest in discussions relating to differentiation. (Kemp)

Estéril (Sp.). 1. Veinstone. 2. Barren rock. Often used in plural. (Halse)

Estibnita (Sp.). Stibnite. (Dwight)

Estopa (Mex.). Cotton waste. (Dwight)

Estoraque (Mex.). Resin; yellow zinc-blende. (Dwight)

Estovers (Eng.) Necessary supplies, especially wood which a tenant is allowed to take from the landlord's premises, for the necessary fuel, repairs, etc., for himself. (Webster)

Estrada (Port.). A road; *E. de ferro*, a railroad. (Halse)

Estratificación (Sp.). Stratification. (Dwight)

Estrato (Sp.). Stratum; layer; bed. (Halse)

Estrechamiento del filón (Sp.). Pinching; pinching out. (Lucas)

Estrellarse la veta (Peru). To "peter out." or become lean, especially by scattering. (Dwight)

Estriada (Sp.). Striated. (Dwight)

Estribo. 1. (Sp.). Stirrup. 2. (Mex.) Hogback in a mountain; a spur. (Dwight)

Estrujar (Sp.). To press or squeeze amalgam. (Halse)

Estrujón (Mex.) A second collection of amalgam, generally very pasty. (Dwight)

Estuarine. Of, pertaining to, or formed in an estuary. (Webster)

Estuary. A bay, as the mouth of a river, where the tide meets the river current. A frith. (Webster)

Estufa. 1. A stove or tubular apparatus for heating air for hot blast. 2. (Mex.) In the *patio* process, a chamber with flues under the floor for heating the *torta*. (Halse)

Estufa amalgamación (Sp.). A modification of the *patio* process, using heat. (Raymond). *See* Estufa, 2.

Etch figure. A marking, usually minute pits, produced by a solvent on a crystal surface; the form varies with the species and solvent but conforms to the symmetry of the crystal, hence revealing its molecular structure. (Webster)

Etching. A process of engraving in which the lines are produced by the action of an acid or mordant (Century). Used also in studying the composition and structure of metals and crystals.

Éter (Sp.). Ether. (Dwight)

Ethane. A colorless, gaseous compound (C_2H_6), of the paraffin series contained in the gases given off by petroleum and in illuminating gas. (Standard)

Ether. 1. A hypothetical medium of extreme elasticity and supposed to be diffused throughout all space as well as among the molecules of which solid bodies are composed and to be the medium of the transmission of light and heat. 2. A highly volatile inflammable, light, mobile, colorless liquid used as an anesthetic and solvent. (Century)

Ether axes. *See* Axes of elasticity.

Ethmolith. A plutonic mass of rock which narrows downwardly. (Daly, p. 88)

Ettle (No. of Eng.). 1. Waste (Gresley). *See* Attle, 1.
2. To intend, appoint, arrange (G. C. Greenwell). *See* Attle, 2.

Ettlings (No. of Eng.). Earnings; wages. (Century)

Euchroite. A vitreous, bright emerald—or leek-green, transparent to translucent hydrous copper arsenate, $Cu_2As_2O_8.Cu(OH)_2+6H_2O$, mineral crystallizing in the orthorhombic system. (Dana)

Euclase. A vitreous, colorless to pale green or blue glucinum-aluminum silicate mineral, $2BeO.Al_2O_3.2SiO_2.H_2O$, crystallizing in the monoclinic system. (Dana)

Eucrite. A name given by G. Rose to rocks and meteorites that consist essentially of anorthite and augite. The term is practically obsolete. (Kemp)

Eudiometer. An instrument for the volumetric measurement and analysis of gases. (Webster)

Eudyalite. Essentially a metasilicate of Zr, Fe (Mn), Ca, Na, etc., in red to brown tabular or rhombohedral crystals; also massive (Dana). The name of the mineral is sometimes prefixed to the rare nephelite-syenites that contain it. (Kemp)

Eugranitic. Same as Granitoid. (Standard)

Euhedral. In petrology, bounded by its own crystal faces; automorphic: said of some minerals in a crystalline rock and contrasted with subhedral and anhedral. (La Forge)

Euktolite. A name derived from the Greek words for "desired rock" and given by H. Rosenbusch to one which filled a gap in his classification of rocks. The same rock had been previously named Venanzite. (Kemp)

Eulysite. A name given by Erdmann to rocks interlaminated with the gneisses of Sweden, and consisting of olivine, green pyroxene, and garnet. (Kemp)

Eulytite. A silicate of bismuth, $Bi_4Si_3O_{12}$, occurring usually in minute dark brown or grayish tetrahedral crystals. (Dana)

Euosmite. An amorphous, brownish yellow, brittle, oxygenated hydrocarbon from clefts in brown coal at Baiershof, near Thumsenreuth, in the Fichtelgebirge; it has a specific gravity of 1.2 to 1.5, and dissolves easily in alcohol and ether. (Bacon)

Euphotide. The name chiefly used among the French for gabbro. It was given by Hauy, and is derived from the Greek words for well and light, in allusion to its pleasing combination of white and green. (Kemp)

Euphyllite. A white sodium-potassium mica that is intermediate between paragonite and muscovite. (Standard)

Eurite. Used among the French as a synonym for felsite, but also applied to compact rocks chiefly feldspar and quartz, such as some granulites. The name was first given by Daubisson to the groundmass of porphyries, because of their easy fusibility compared with hornstone or flint. (Kemp)

Europium. A metallic element of the rare-earth group, discovered in 1896. Symbol Eu; atomic weight, 152.0. (Webster)

Eustatic. Pertaining to or designating a land area which undergoes neither elevation nor depression. (Webster)

Eutaxitic. A general name for banded volcanic rocks. The banding is due to the parallel arrangement of portions of the rock that are contrasted either in mineralogy or texture (Kemp). Contrasted with Ataxitic.

Eutectic. Of maximum fusibility; said of an alloy or solution having the lowest melting point possible with the given components. (Webster)

Eutomous. In mineralogy, having distinct cleavage; cleaving readily. (Century)

Euxenite. In mineralogy, a niobate and titanate of yttrium, erbium, cerium and uranium. (Dana)

Evansite. In mineralogy, a massive, colorless to milk white, hydrous aluminum phosphate, $2AlPo_4.4Al(OH)_3+12H_2O$. (Dana)

Evaporar (Colom.). To retort amalgam. (Halse)

Evaporate. To convert into vapor, usually by means of heat; vaporize; also, to remove and dissipate by this process. (Standard)

Evaporating dish, or pan. A shallow dish, of glass, porcelain, or metal used in processes requiring evaporation.

Evaporation gage. A graduated vessel of glass for determining the rate of evaporation of a liquid placed in it, in a given time and exposure. (Century)

Everlasting lamps (No. of Eng.) Natural jets of fire damp or small blowers which continue to burn as long as gas is given off. (Gresley)

Everson process. An oil flotation process involving the use of from 6 to 20 per cent oil and usually less than 1 per cent acid. (Megraw, p. 8)

Excambion (Scot.). An exchange of land or minerals. (Barrowman)

Excavar (Sp.). To excavate; to dredge. (Halse)

Excavation. 1. In engineering, an open cutting, as in a railway in distinction from a tunnel. 2. The act of digging out of material (earth, rock, etc.) by any means so as to form a cavity. (Century)

Excavator. A steam or electric power-machine for removing earth, rock, etc., as a steam shovel, dredge, etc.

Excessive location. A mining claim in excess of the width allowed by law. (U. S. Min. Stat., pp. 90, 538–539)

Exempted claim. A claim which, by the mining laws has been allowed to remain idle, and for which an exemption certificate has been obtained (Morine). Common, especially in Canada and Australia.

Exfoliate. 1. To peel off in concentric layers, as some rocks do by weathering. In this way the concretionary

structure of some kinds of greenstones is well brought out, the weathered surface showing rounded masses with the successive spherical layers falling off. (Roy. Com.)
2. To swell up and open into leaves or plates like a partly opened book. (George)

Exhalation. 1. Any vapor or gaseous matter arising from substances or surfaces exposed to the atmosphere. (Power)
2. In geology, any gas or vapor formed beneath the surface of the earth and escaping either through a conduit or fissure or from molten lava or a hot spring; an emanation. (La Forge)

Exhaust fan. A fan used for creating a draft by the formation of a partial vacuum in contradistinction to a blower. (Century)

Exhaustion. 1. In chemistry, the process of completely extracting from a substance whatever is removable by a given solvent. (Century)
2. In mining, the complete removal of ore reserves.

Exhibición (Mex.). Exhibition; assessment. (Dwight)

Exomorphic. A descriptive term for those changes which are produced by contact-metamorphism in the wall rock of the intrusion; the antithesis of endomorphic. (Kemp)

Exosmosis. *See* Endosmosis.

Exothermic. Pertaining to a chemical reaction which occurs with the evolution of heat. (Webster)

Exotic. That which has been introduced from other regions. (Power)

Expander. A device for expanding the end of a tube, in a tube-plate or as a casing in a well.

Expansion bit. A drill bit that may be adjusted for holes of various sizes.

Expansion joint. A device used in connecting up long lines of pipe, etc., to permit linear expansion or contraction as the temperature rises or falls. (Nat. Tube Co.)

Expansion loop. Either a bend like the letter U or a coil in a line of pipe to provide for expansion or contraction. (Nat. Tube Co.)

Expansion ring. A hoop or ring of U-section used to join lengths of pipe so as to permit of expansion. (Nat. Tube Co.)

Expansion tamping. A term used in quarrying when the drill hole above the powder charge is filled for several inches with hay, tow, or the like, followed by several inches of clay lightly tamped and finally by well-packed stemming. (Gillette, p. 442)

Expert. One who has special skill or knowledge in a particular subject, as a science or art, whether acquired by experience or study; a specialist (Webster). Often applied to a mining engineer, as a mining expert.

Explode. To burst or expand violently and noisily, as gunpowder explodes, or as a boiler explodes (Webster), or as an explosion of gas, or coal dust.

Exploder. A cap or fulminating cartridge, placed in a charge of gunpowder or other explosive, and exploded by electricity or by a fuse. Also called Detonator. (Raymond)

Exploit. 1. To make complete use of; to utilize. 2. To make research or experiment; to explore. 3. To employ or utilize selfishly, without regard to right or justice. (Century)

Exploitation. The extraction and utilization of ore. Often confused with "exploration." (Rickard)

Exploración (Sp.). 1. Exploration; prospecting. 2. A prospect. (Dwight)

Explorar (Sp.). To prospect; to explore. (Halse)

Exploration. 1. The work involved in looking for ore. Often confused with "exploitation." (Rickard)
2. A mode of acquiring rights to mining claims. (Collins *v.* Bubb, 73 Fed. Rept., p. 739)

Exploring mine (Scot.). A working place driven ahead of the others to explore the field (Barrowman). A prospect.

Explosion. 1. A sudden ignition of a body of fire damp, coal dust, or explosives, as powder, dynamite, etc. (Steel)
2. The act of exploding; rapid combustion, decomposition, or other similar process resulting in a great and sudden development of gases, and consequent violent increase of pressure, usually accompanied by a loud report. 3. A sudden breaking apart, shattering or bursting in pieces by internal pressure, as that of gas or steam. (Standard)

Explosion proof. The term "explosion-proof casing or inclosure" means an inclosure that is so constructed and maintained as to prevent the ignition of gas surrounding it by any sparks, flashes, or explosions of gas that may occur within such inclosure. (H. H. Clark, U. S. Bur. Mines)

Explosion-proof motors. The Bureau of Mines has applied the term "explosion proof" to motors constructed so as to prevent the ignition of gas surrounding the motor by any sparks, flashes, or explosions of gas or of gas and coal dust that may occur within the motor casing.

Explosions from molten iron. An explosion caused by molten iron escaping and coming in contact with water or wet material. (Wilcox)

Explosion wave. From the French *Onde Explosive*, and coined by Bertholet, signifying that wave or "flame" which passes through a uniform gaseous mixture with a permanent maximum velocity. The rate of the explosion wave is a definite physical constant for each mixture; the explosion wave travels with the velocity of sound in the burning gas which itself is moving rapidly forward *en masse* in the same direction, so that the explosion wave is propagated far more quickly than sound travels in the unburned gas. (H. B. Dixon, First Series, Brit. Coal-Dust Experiments, 1908–09, p. 150)

Explosive. Any mixture or chemical compound by whose decomposition or combustion gas is generated with such rapidity that it can be used for blasting or in firearms, for example, gunpowder, dynamite, etc.

Explosive oil. Nitroglycerin. (Brunswig, p. 295)

Explosive, permissible. *See* Permissible explosive.

Explosive volcano. A volcano characterized by periodic eruptions of great violence and explosive force. (Standard)

Explotación de minas (Sp.). Mining; winning; working. (Lucas)

Explotar (Sp.). To exploit, work, or win; *E. una mina*, to work a mine. (Halse)

Exposure. In geology, the condition or fact of being exposed to view, either naturally or artificially; hence, also, that part of a rock, bed, or formation which is so exposed; an outcrop. (La Forge)

Expropiar (Sp.). To expropriate. (Dwight)

Extencteur (Fr.). An apparatus which discharges onto a burning mass of coal, water charged with carbonic acid under a very high pressure. (Gresley)

Extinction. In optical mineralogy, the arresting of a beam of light by polarization, by the imperfect transparency of the medium, or otherwise. (Century)

Extinction angle. The angle through which a section of an anisotropic crystal must be revolved from the direction of a known crystallographic plane to that of maximum darkness under the polariscope. (Dana)

Extinction direction. In optical mineralogy, the position of extinction. (A. F. Rogers)

Extoölitic. An oölitic structure built up around a core from within outward; a small concretion. Opposed to entoölitic. (Power)

Extracción (Sp.). 1. Extraction; winding, or hoisting. 2. Output, or production, as of a mine. (Halse)

Extraction. A designation for that part of the metallic content of the ore which is obtained by a final metallurgical process, as the extraction was 85 per cent. *Compare* Recovery.

Extracto (Sp.). Extract; *extractos* (Mex.), a summary of an application for a mining concession, published on the bulletin board; excerpts. (Halse)

Extractor. One who or that which extracts; as a drill-extractor. (Standard)

Extractor box. *See* Zinc-box.

Extra dynamite. The present designation of those explosives consisting of nitroglycerin, other explosive ingredients and an active base absorbent. They are more easily affected by water than straight dynamite, but give off less noxious fumes, are less sensitive to blows, and they ignite less easily from sparks. (Du Pont)

Extraer. 1. (Sp.) To extract, wind or hoist. 2. To pump. (Halse)

Extrahazardous. Unusually dangerous: specifically used in insurance in classifying occupational risks, as mining is extrahazardous.

Extralateral. Situated or extending beyond the sides; specifically noting the right of a mine owner to the extension of a lode or vein from his claim beyond the side lines, but within the vertical planes through the end lines. (Century)

Extralateral right. In the United States Mining law, said of the right which one who locates on the public domain, a claim in which a vein comes to an apex, has to parts of the vein beyond the planes passed through the side lines of his claim, but lying within vertical cross planes passed through the end lines. (Webster; also, U. S. Min. Stat., pp. 133–159)

Extralite. An explosive mixture of ammonium nitrate, potassum chlorate, and naphthalene. (Webster)

Extramorainic. Situated outside of or beyond the terminal moraine of a glacier. (Century)

Extraordinary ray. That ray of polarized light which, in doubly refracting crystals, has a variable value and therefore does not obey the sine law. (Dana)

Extraviado (Mex.). Astray in a mine. (Dwight)

Extrio (Sp.). Hand picking. (Lucas)

Extrusive. A term applied to those igneous rocks which have cooled after reaching the surface (Ries). A synonym for Effusive, and much used in America. (Kemp)

Exudation-vein. *See* Segregation-vein.

Exude. 1. To discharge gradually through pores or small openings, as liquid, gum (oil or gas); give off or out by slow percolation; as the pines exude pitch. 2. To ooze or flow slowly forth through pores, cracks, or gashes; as gums exude from wounded trees, or gas (and oil) exudes from the underlying formation. (Standard)

Eye. 1. The top of a shaft. 2. The opening at the end of a tuyère of a blast furnace, opposite the nozzle. 3. The hole in a pick or hammer head which receives the handle. (Raymond)
4. The central or intake opening of a fan.

Eye of a shaft. *See* Eye, 1.

Eyestone (Eng.). A variety of agate which shows in the center, a spot or spots more highly colored than the concentric layers. (Page)

Esteri (Sp. Am.). A green jasper with reddish veins; a kind of bloodstone. (Halse)

F.

Faber du Faur furnace. A cubical crucible furnace built into cast-iron framework, mounted on trunnions in order that the furnace may be turned over and the contents emptied. Used in the desilverization of zinc crusts. (Hofman, p. 485.)

Fabian system. *See* Freefall. May be described as the father of freefall drilling systems, all others having originated from it, although it is not now used in its original form. (Mitzakis)

Fabric. In petrology, that factor of the texture of a crystalline rock which depends on the relative sizes, the shapes, and the arrangement of the component crystals. (Iddings)

Face. 1. In any adit, tunnel, or stope, the end at which work is progressing or was last done. 2. The *face of coal* is the principal cleavage-plane at right angles to the stratification. Driving on the face is driving against or at right angles with the face. (Raymond)
3. A point at which coal is being worked away, in a breast or heading; also working face. (Gliebas v. Spring Valley Coal Co., 159 Illinois App., p. 90)
4. The surface exposed by excavation. The *working face, front,* or *forehead,* is the face at the end of the tunnel heading; or at the end of the full-size excavation. (Simms)
5. A cleat or back. 6. (Lanc.) To place a full tub in position for being lowered on an incline. (Gresley)
7. One of the flat, more or less smooth, surfaces of a crystal. (A. F. Rogers)

Face airing (No. of Eng.) That system of ventilation in which all of the air sweeping through the mine, ventilates the working faces and main roads only. (Gresley)

Face cleat. A well-defined joint or cleavage plane in a coal seam. *Compare* Butt cleat. *See* Face, 2.

Face entry. The gallery of a mine driven at right angles with the face cleat of the coal. (Roy) *See also* Face, 2.

Face-on. When the face of the breast or entry is parallel to the face cleats of the seam. (Steel). *See* Face, 2.

Face slip. The front slip of a coal seam. (Roy)

Facet. The polished surface of a cut-stone. (A. F. Rogers)

Face wall. A wall built to sustain a face cut into the earth in distinction to a retaining wall, which supports earth deposited behind it. (C. and M. M. P.)

Facies. Variety; especially applied to an igneous rock that in some respects is a departure from the normal or typical rock of the mass to which it belongs. Thus a mass of granite may grade into porphyritic *facies* near its borders. (Ransome)

Facing. 1. (Aust.) The main vertical joints often seen in coal seams; they may be confined to the coal, or continue into the adjoining rocks (Power). *See also* Cleat.
2. Powdered coal or charcoal applied to the face of a mold or mixed with sand that forms it, to give a fine smooth surface to the casting. (Webster)

Factor. 1. One who makes it his business to sell merchandise or property intrusted to him for that purpose, receiving a commission on the amount of sales; a commission merchant; often in combination with the name of the merchandise; as, coal-*factor*. *Factors* and brokers are both and equally agents, but with this difference: the *factor* is intrusted with the property which is the subject-matter of the agency; the broker is only employed to make a bargain in relation to it. (Standard)
2. One of the several elements, circumstances, or influences which tend to the production of a given result. (Century)

Faddom (Eng.). A fathom, 6 feet, commonly used as a measure by miners. (Hunt)

Faenas. 1. (Sp.) Work; labor; task. 2. (Mex.) Dead work, as putting up an air shaft, or unwatering a mine. (Halse)

Faenero (Braz.). A common laborer. (Halse)

Faenza white. In ceramics, a fine enamel of stannic oxide characteristic of some varieties of majolica-ware. (Standard)

Fagot. *See* Pile, 1 and 2.

Fahlband. A term originally used by German miners to indicate certain bands of schistose rocks impregnated with finely divided sulphides but not always rich enough to work. (Watson, p. 606)

Fahlerz (Ger.). A gray copper ore. Sometimes called Fahl ore.

Fahlite. A variant of Fahlerz. (Chester)

Fahl ore. Same as Fahlerz.

Fahlunite. An altered form of iolite. (Dana)

Fahrenheit. Designating a thermometer scale, on which the freezing point of water is 32° and the boiling point is 212°. To convert Fahrenheit readings to centigrade readings, subtract 32° from the former and then divide by 1.8. (C. and M. M. P.)

Fahrkunst (Ger.). An apparatus for lowering and raising men in a shaft. *See also* Man machine. (Gresley)

Faikes; Faiks; Fakes (Scot.). Fissile sandy shales. (Power)

Failed hole. A drill hole in which dynamite has been loaded and fails to explode. (Cook *v.* Cranberry Furnace, 76 S. E. Rept., p. 473)

Fair-lead. A block, ring, or strip of plank with holes, serving as a guide for the running rigging or for any other rope, to keep it from chafing or fouling (Webster). Originally a nautical term but now also used in dredging.

Fairy stone. 1. (Scot.) A fantastically-shaped calcareous or ferruginous concretion formed in alluvial clays. (Power)
2. A stone arrowhead. (Webster)
3. A fossil sea-urchin or echinite. (Standard)

Faiscador (Mex. and Braz.). A placer miner; gold washer. (Halse)

Faisqueira (Braz.). A place where gold is found; a placer. (Halse)

Faixa (Port.). 1. A band of ore. 2. A belt of rock. (Halse)

Faja (Sp.). 1. A band of mineral in a vein. 2. A band or belt of rock. 3. A horizontal cut in a vein. (Halse)

Fake. 1. (Scot. and Eng.) *See* Falkes. 2. A soft soldering fluid used by jewelers. (Century)

Falda (Sp.). Slope; flank of hill. (Dwight)

Faldeos (Bol.). Ancient gold-bearing alluvial deposits. (Halse)

Falding furnace. A mechanically raked muffle furnace having three hearths with combustion flues under the lowest hearth. (Ingalls, p. 141)

Fall. 1. A mass of roof or side which has fallen in any subterranean working or gallery, resulting from any cause whatever. 2. A length of face undergoing holing or breaking down. for loading. 3. (Eng.) To blast or wedge down coal, etc., in the process of working it. 4. To crumble or break up from exposure to the weather; clays, shales, etc., fall. (Gresley) 5. To break down; to collapse. 6. A vertical or sloping descent of flowing water; a waterfall. 7. Descent from a higher to a lower level. (Webster)

Falla. 1. (Mex.). A vein of soft rock at right-angles to drift. (Dwight) 2. (Sp.) A fault; *F. Falsa*, an interruption in a bed or seam; a horse. (Halse)

Fallers (Lanc.). A synonym for Cage shuts.

Falling (Scot. and No. of Eng.). An overlying stratum which falls or comes down as the mineral is extracted from under it. Sometimes called Following. (Barrowman)

Falling stone. A meteorite. (Webster)

Fall line. A line characterized by numerous waterfalls, as the edge of a plateau in passing which the streams make a sudden descent. (Webster)

Fall of ground. Rock falling from the roof into a mine opening (Weed). *See also* Fall, 1.

Falls. Working by falls. A system of working a thick seam of coal by falling or breaking down the upper part after the lower portion has been mined. (Gresley). *Compare* Caving system.

False amethyst. An early name for violet-colored fluorite when cut as a gem. Other colors of the same mineral were called false emerald, ruby, sapphire, or topaz. (Chester)

False bedding. Current bedding. Laminations in sandstone parallel to each other for a short distance, but oblique to the general stratification; caused by frequent changes in the currents by which the sediment was carried along and deposited (Power). *See also* Cross-bedding.

False bottom. 1. A floor of iron placed in a puddling machine. (Davies) 2. (Aust. and Amer.) A bed of drift lying on the top of other alluvial deposits, beneath which there may be a true bottom, or a lower bed of wash resting directly upon the bed rock. (Skinner) 3. A flat hexagonal or cylindrical piece of iron upon which the ore is crushed in a stamp mill. The die. At Clunes, Victoria, Australia, it is called Stamper bed.

False cleavage. A secondary cleavage superinduced on slaty cleavage. (C. and M. M. P.)

False Galena. Sphalerite. (Webster)

False part. A part of a flask used temporarily in forming a mold. (Standard)

False set. A temporary set of mine timber used until work is far enough advanced to put in a permanent set. (Steel)

False stull. A stull so placed as to offer support or reinforcement for a stull, prop or other timber. (Sanders, p. 44)

False superposition. The actual or visible order in which strata lie in any locality in case of overturn, as the older rocks have been thrust over the newer ones. (Standard)

False topaz. A yellow variety of quartz resembling topaz. (Dana)

Falso. 1. (Sp.) False; counterfeit. 2. (Mex.) Treacherous ground. *See also* Flojo. (Halse)

Falta de explosión (Sp.). Spent shot; misfire. (Lucas)

Faluns. A French term applied to some Tertiary strata, resembling the English crag. (St. John)

Famatinite. A copper-antimony sulphide, $8Cu_2S.Sb_2S_3$, mineral containing 43.8 per cent copper. (U. S. Geol. Surv.)

Famp. 1. (Cumb.) Decomposed limestone, but in some other districts a very fine-grained siliceous bed. (Hunt)
2. (Newc.) Soft, tough, thin shale beds. (Raymond)

Famulia (Peru). A wedge; a gad. (Dwight)

Fan. A revolving machine, to blow air into a mine (pressure fan, blower), or to draw it out (suction fan). (Raymond)

Fancy lump coal. 1. Soft coal from which all slack and nut coal has been removed. 2. (Ark.) Semi-anthracite coal of larger size than grate coal. (Steel)

Fan drift. A short tunnel or conduit leading from the top of the air shaft to the fan. (Steel)

Fanega (Mex.). A variable unit of dry measure, usually 90.815 liters; of superficial measure usually 3.5663 hectares. (Dwight)

Fang. 1. (Scot.) The power of a pump bucket to form a vacuum. Hence a pump has "lost the fang" when so much air passes the bucket that a vacuum can not be made until water is poured on the top of the bucket. (Barrowman)
2. (Derb.) An air course, cut in the side of the shaft or level, or, constructed of wood. (Raymond)
3. (Wales) In the plural, cage shuts. (Century)

Fanging; Fanging-pipes (Eng.). Wooden air-pipes used in mine ventilation (Century). *See* Fang, 2.

Fanner (Scot.). A small portable hand fan (Barrowman). *See* Blowgeorge.

Fan shaft. 1. A shallow shaft sunk beneath a fan connecting it with the fan drift. 2. The upcast shaft where a fan is in use. (Gresley)

Fan structure. An arrangement of closely folded strata such that the axis planes of the folds dip on each side of a mountain pass or range toward the central-axis plane of the range itself, so that the whole has a structure, as exhibited in cross section, resembling that shown by an open fan held upright. (Century)

Farad. The practical unit of electrical capacity; the capacity of a condenser which, charged with one Coulomb, gives a difference of potential of one volt. (Webster)

Faraday's law. 1. The quantity of substance liberated at the cathode or anode is proportional to the quantity of current passed. 2. The quantities of different substances liberated by the same quantity of current are proportioned to their chemical equivalents. (Webster)

Farrallón (Peru). An outcrop projecting above country-rock. (Dwight)

Fare (Wales). Standing coal, or coal unholed or uncut. (Gresley)

Farewell rock (Eng.). The Millstone grit, so called because no coal is found, worth working, below it. It is used for furnace hearths, being highly refractory. (Webster)

Farm (Eng.). 1. To let at a fixed rental: said of mineral lands.
2. (Corn.) That part of the lord's fee, generally one-fifteenth, which is taken for liberty to work in tin mines. (Min. Jour.)

Farrisite. A name derived from Lake Farris in Norway, and applied by Brögger to a very peculiar rock, which is as yet known only in one small dike. The rock is finely granular in texture and consists of some soda-bearing, but not sharply identified, tetragonal mineral related to melilite, together with barkevicite, colorless pyroxene, biotite, serpentinous pseudomorphs after olivine, magnetite, and apatite. (Kemp)

Far set (Mid.). To timber and sprag the far end of a stall, preparatory to holing. (Gresley)

Fascine (Fr.). A fagot; a bunch of twigs and small branches used for forming foundations on soft ground. (C. and M. M. P.)

Fast. 1. (Lanc.) The first hard bed of rock found after sinking through sand or quick ground, upon which a wedging crib is generally laid. 2. When a heading or bord end is not in communication with another one by a break through, but has only one open end, it is said to be *fast* or called a *fast place*. (Gresley)

Fast-end. 1. The part of the coal bed next the rock. 2. A gangway with rock on both sides. *See* Loose-end. (Raymond)
3. The limit of a stall in one direction, or where the face line of the adjoining stall is not up or level with, nor in advance of, it. (Gresley)

Fast-in-the-foot (Scot.). When the suction holes of a pump are filled up, the pump is said to be fast-in-the-foot. (Barrowman)

Fast jenkin (Eng.). *See* Jenkin. Sometimes spelled Jenking.

Fast place (Scot.). A drift or working place in advance of the others. (Barrowman)

Fast shot (Newc.). A charge of powder exploding without the desired effect. (Raymond)

Fast side (Scot.). The side not sheared in a room where shearing is done on one side only. (Barrowman)

Fast wall (Eng.). The wall in which bearing doors are placed. (G. C. Greenwell)

Fat. A white or yellowish substance forming the chief part of adipose tissue. It may be solid or liquid; it is insoluble in water; when treated with an alkali, the fatty acid unites with the alkaline base to make soap (Rickard). A term used in flotation.

Fat coal; Gas coal. Coals containing much volatile oily matter. (Power)

Fathom (Corn.). Six feet. A fathom of mining ground is six feet square by the whole thickness of the vein, or in Cornish phrase, a fathom forward by a fathom vertical. (Raymond)

Fathomage (Scot.). Payment made to miners per fathom driven or cut. (Barrowman)

Fathom-tale (Corn.). *See* Tutwork, 2. This name probably arises from the payment for such work (tutwork) by the space excavated, and not by the ore produced. (Raymond)

Fatigue. 1. To weary with labor or any bodily or mental exertion. 2. The weakening of a metal bar by the repeated application and removal of a load considerably less than the breaking weight of the bar. (Century)

Fat-lute. A mixture of pipe clay and linseed oil, used for filling joints, apertures, etc. (Century)

Faucet. 1. A device to control the flow of liquid. Commonly called a *tap* and used in house plumbing to draw water. 2. Enlarged end of a pipe to receive the spigot end of another pipe, *i. e.*, a bell end. (Nat. Tube Co.)

Fauld. 1. The tymp-arch or working-arch of a furnace. (Raymond) 2. (Scot.) Same as fold. (Standard)

Faulding or folding-boards (Scot.). Cage-catches or shuts in mid-workings. (Gresley)

Fault. 1. In geology, a break in the continuity of a body of rock, attended by a movement on one side or the other of the break so that what were once parts of one continuous rock stratum or vein are now separated. The amount of displacement of the parts may be a few inches or thousands of feet. Various descriptive names have been given to different kinds of faults as follows:
Closed fault. A fault in which the two walls are in contact (Lindgren, p. 117). *Dip.* A fault whose strike is approximately at right angles to the strike of the strata (Lindgren, p. 120). *Dip Slip.* A fault in which the net slip is practically in the line of the fault dip (Lindgren, p. 126). *Distributive. See* Slip fault. *Flaw.* A rare type of fault, described by Luess, in which the strike is transverse to the strike of the rocks, the dip high and varying from one side to the other in the course of the fault, and the relative movement practically horizontal and parallel with the strike of the fault (Lindgren, p. 128). *Gravity. See* Normal fault. *Hinge.* A faulting about an axis normal to the plane of faulting, which may produce a fault that on one side of the pivotal axis would be called normal and on the other side reverse, yet there may not be any differential movement in the center of the mass of the two parts of the faulted body (Leith, p. 32). *Horizontal.* A fault with no vertical displacement (Webster). *Longitudinal.* A fault whose strike is parallel with the general structure (Lindgren, p. 121). *Normal.* A fault in which the hanging wall has been depressed relatively to the foot wall (Lindgren, p. 126). *Oblique.* A fault whose strike is oblique to the strike of the strata (Lindgren, p. 120). *Oblique slip.* A fault in which the net slip is between the direction of dip and the direction of strike (Lindgren, p. 126). *Open.* A fault in which the two walls are separated (Lindgren, p. 117). *Overlap.* A thrust fault in which the shifted strata double back over themselves (C. and M. M. P.). *Parallel displacement.* A fault in which all

straight lines on opposite sides of a fault and outside of the dislocated zone, that were parallel before the displacement, are parallel afterward (Lindgren, p. 118). *Pivotal. See* Hinge fault. *Reverse.* A fault in which the hanging wall has been raised relatively to the foot wall (Lindgren, p. 126). *Rotary.* A fault in which some straight lines on opposite sides of the fault and outside of the dislocated zone, parallel before the displacement, are no longer parallel, that is, where one side has suffered a rotation relative to the other (Lindgren, p. 118). *Step.* A series of closely associated parallel faults (Webster). *Strike.* A fault whose strike is parallel to the strike of the strata (Lindgren, p. 120). *Strike slip.* A fault in which the net slip is practically in the direction of the fault strike. J. Geike calls such faults "transcurrent faults." Jukes-Brown designates them "heaves" (Lindgren, p. 126). *Thrust. A* reverse fault (Leith, p. 32). *Transcurrent. See* Strike slip fault. *Translatory. See* Rotary fault. *Vertical.* A fault in which the dip is 90 degrees (Lindgren, p. 126).
2. In coal seams, sometimes applied to the coal rendered worthless by its condition in the seam (slate-fault, dirt-fault, etc.). (Raymond)

Fault block. A body of rock bounded by faults. (Webster)

Fault breccia. The breccia which is frequently found in a shear zone, more especially in the case of thrust faults. (Lindgren, p. 118)

Fault bundle. In geology, a group of faults. (Century)

Fault coal (Aust.). A name used for inferior coal in the Clermont district, Queensland, which occurs not only near faults, but also away from them. (Power)

Fault dip. The inclination of the fault plane, or shear zone, measured from a horizontal plane. (Lindgren, p. 118)

Fault escarpment; Scarp. An escarpment or cliff resulting from a fault, or a dislocation of the rocks adjacent (Century). Also called Fault scarp.

Fault fissure. The fissure produced by a fault, even though it is afterward filled by a deposit of minerals. (Century)

Faulting. In geology, the movement which produces relative displacement, along a fracture, of adjacent rock masses. (La Forge)

Fault line. The intersection of a fault surface or plane with the surface of the earth or with any artificial surface of reference. (Lindgren, p. 117). *Compare* Trend.

Fault plane. A surface along which dislocation or faulting has taken place.

Fault rock. The crushed rock due to the friction of the two walls of a fault rubbing against each other. (Power)

Fault space. The space between the walls of an open fault. (Lindgren, p. 117)

Fault strike. The direction of the intersection of the fault surface, or the shear zone, with a horizontal surface. (Lindgren, p. 118)

Fault surface. The surface along which dislocation has taken place. May be called a fault plane if it is without notable curvature. (Lindgren, p. 117)

Fault terrace. A terrace formed by two parallel fault-scarps on the same declivity, "thrown" in the same direction. (Standard)

Fault trace. The line of intersection of a fault plane with the surface. (Leith, p. 32). *Compare* Trend.

Fault vein. A mineral vein deposited in a fault fissure. (Century)

Fault vent. A volcanic vent located on a fault. (Century)

Fauna. The animals collectively of any given age or region. The plants are similarly called its *Flora.* (Roy. Com.)

Fausted ore (Eng.). Refuse lead ore, which undergoes a second dressing. (Bainbridge)

Fausteds (Eng.). The waste left in the sieve as separated from the ore. (Hunt)

Fauvelle. A system of drilling, that was invented in 1846 by an Englishman, Beart, and a French engineer, Fauvelle, providing for the continuous removal of the detritus from the well by means of a water flush or current of water. All the water-flush systems now in use are modifications of the Fauvelle system, which has long ceased to be employed in its original form. (Mitzakis)

Favas (Braz.). In the diamond fields, brown pebbles, consisting of a hydrated phosphate, or of titanium and zirconium oxides, and regarded as good indications. (Halse)

Fayalite. A silicate of iron, Fe_2SiO_4, belonging to the chrysolite group. (Dana)

Feasible ground. Ground that can be easily worked, and yet will stand without the support of timber and boards. (Pryce)

Feather. *See* Plug and feather.

Feather alum. *See* Alunogen; Halotrichite.

Feather edge. The thin end of a wedge-shaped piece of rock or coal. (Steel)

Feathered tin. Pure tin in a granulated condition; granulated tin: prepared by pouring the molten metal into cold water. (Standard)

Feathering. *See* Plug and feather.

Feather ore. An early German name under which were included fibrous stibnite and jamesonite, but now used only for the latter. (Chester)

Feathers. Two long wedge-shaped pieces of steel or iron which are inserted at the back of a drill hole in coal, between which a long wedge is driven up, forcing the feathers apart, and thereby breaking down or loosening the coal (Gresley). *See* Plug and feather.

Feather shot. Copper granulated by being poured molten into cold water. (Webster)

Feathers of litharge. Crystals of litharge. (Ricketts, p. 102)

Feather zeolite. An erroneous translation of *Faserzeolith*, an early name for a variety of natrolite. (Chester)

Fee. 1. (Mid.) To load the coal, from a heading into cars. (Gresley)
2. Reward or compensation for services rendered, or to be rendered; especially payment for professional services. 3. Property, as mineral land. (Webster)

Feed. 1. Forward motion imparted to the cutters or drills of rock-drilling or coal-cutting machinery, either hand or automatic. (Gresley)
2. The material, as ore, upon which a crusher or grinding mill operates. The material supplied to a furnace or other metallurgical process. 3. In stone cutting, sand and water employed to assist the saw blade in cutting.

Feeder. 1. Small vein joining a larger vein. 2. A spring or stream. 3. A blower of gas, as in a coal mine. (Raymond)
4. A device for feeding ore uniformly to a rock crusher. It usually has a motion imparted to it to aid in feeding the material. (Richards, p. 71)

Feed-water heater. An apparatus for heating water before it is fed to a boiler. (Standard)

Fee engineer. One who (usually a mining engineer) looks after the interests of the owner of mineral rights. His specific duties are to check up the amount of ore mined by the lessor (operator); see that no undue waste is permitted, and that royalties are paid according to contract.

Feel (So. Staff.). To examine the roof of a seam of coal with a stick or rod by poking and knocking it. (Gresley)

Feigh (Newc., Derb.). Refuse washed from lead ore or coal. (Raymond)

Feitor (Braz.). An overseer. (Halse)

Fekes (Scot.). Shale and slate. (Power) *See also* Faikes.

Feldespato (Sp.). Feldspar. (Halse)

Feldspar. A general name for a group of abundant rock-forming minerals, the names and compositions of which are as follows: *Orthoclase*, a monoclinic potassium-aluminum silicate, $K_2O.Al_2O_3.6SiO_2$; varieties are known as adularia and sanidine. *Microcline*, a triclinic variety of the same composition as orthoclase. *Anorthoclase*, a triclinic feldspar containing both sodium and potassium.

Plagioclase feldspars are a subgroup of triclinic minerals at one end of which is albite, a sodium-aluminum silicate, $Na_2O.Al_2O_3.6SiO_2$; and at the other end anorthite, a calcium-aluminum silicate, $CaO.Al_2O_3.2SiO_2$. Mixtures of these two molecules, which may be represented by Ab and An, respectively, form:

Oligoclase, Ab_3An_1 to Ab_2An_1.
Andesine, Ab_2An_1 to Ab_1An_1.
Labradorite, Ab_1An_1 to Ab_1An_3.
Bytownite, Ab_1An_3 to Ab_1An_6.

Celsian is similar to anorthite, but contains barium in place of calcium,

$BaO.Al_2O_3.2SiO_2$. *Hyalophane* is a monoclinic form containing barium and calcium. Feldspar is found in practically all igneous rocks. (U. S. Geol. Surv.)
The name of the mineral is often prefixed to the names of those rocks that contain it, such as feldspar-porphyry, feldspar-basalt, etc. (Kemp)

Feldspathization. Metamorphic alteration of other material into feldspar.

Feldspathic. Containing feldspar as a principal ingredient. (Raymond)

Feldspathize. To change to feldspar: a term used in geology to describe this metamorphic process. (Century)

Feldspathoids. Silicates of aluminum and an alkali or alkaline earth, that are practically equivalent to feldspar in their relations in rocks. The principal ones are nephelite, leucite and melilite, but sodalite, noselite, hauynite, and analcite could perhaps be also considered such, although their composition varies from the above. (Kemp)

Fell. 1. One of the many names for lead ore, formerly current in Derbyshire, England. *See also* Riddle. (Duryea)
2. The finer pieces of ore which will pass through the sieve or riddle in sorting. (Standard)

Fell heap (Derb.). A pile of ore and rock as it comes from the mine, placed in a convenient place for dressing. (Mander)

Fells shale. A Scottish oil shale, which yields from 26 to 40 gal. of crude oil and from 20 to 35 lb. of ammonium sulphate per ton. (Bacon)

Felsic. A short term applicable to the group of feldspathic minerals and quartz and to the rocks composed predominantly of these minerals. *Compare* Mafic. (Ransome)

Felsita (Sp.). Felsite. (Halse)

Felsite. The word was first applied in 1814 by Gerhard, an early geologist, to the fine ground-mass of porphyries. These were recognized to be fusible as distinguished from hornstone, which they resembled (*Compare* Eurite). Felsite is now especially used for those finely crystalline varieties of quartz-porphyries, porphyries or porphyrites that have few or no phenocrysts, and that, therefore, give but slight indications to the unaided eye of their actual mineralogical composition. The microscope has shown them to be made up of microscopic feldspar, quartz and glass. Petrosilex has been used as a synonym. (Kemp)

Felsitic. 1. In petrology, pertaining to, characteristic of, or composed of felsite. 2. Almost or wholly crystalline, but made up of crystals too small to be readily distinguished by the unaided eye: said of the texture of some igneous rocks and practically synonymous with Aphanitic and Lithoidal. (La Forge)

Felsitoid. Having a felsitic appearance, with an exceedingly compact aphanitic texture: applied to metamorphic rocks. (Century)

Felsöbanyite. A massive snow-white hydrous aluminum sulphate mineral, $2Al_2O_3.SO_3.10H_2O$. (Dana)

Felsophyre. A contraction for felsite-porphyry (Kemp). A porphyritic rock having a felsitic ground mass. (Webster)

Felsophyric. Of porphyritic texture with a felsitic groundmass. (La Forge)

Felspar. *See* Feldspar.

Felstone. A very compact and uniform kind of feldspar (Davies). *See also* Felsite.

Felsyte. *See* Felsite.

Femic. In the Quantitative system of classification of igneous rocks, pertaining to or composed of the standard minerals of the second group, comprising minerals comparatively low in silica and high in iron, magnesium, or calcium: often but incorrectly used in place of Mafic or Subsilicic. (La Forge)

Fence (Aust.). 1. An obstruction, such as a bar or cross-sticks, placed across an underground passage past which men have no right to travel. (Power)
2. To make a drive (trench) around the boundaries of an alluvial claim, to prevent wash dirt from being worked out by adjoining claim holders. (C. and M. M. P.)

Fence guards (So. Staff.). Rails fixed around the mouth of a shaft, or across the shaft at a landing to keep people and objects from falling in. (Gresley)

Fenda (Port.). A fissure. (Halse)

Fend-off; Fend-off bob (Eng.). A beam hinged at one end (the other end having a free reciprocating motion) fixed at a bend in a shaft or upon an inclined plane, to regulate the motion of and to guide the pump rods passing round the bend. (Gresley)

Ferberite. An iron tungstate mineral, $FeWO_4$. Applied to the wolframites which carry little or no manganese. Ferberite contains 76.3 per cent tungsten trioxide, WO_3. (U. S. Geol. Surv.)

Fergusonite. A metacolumbate and tantalate of yttrium, with erbium, cerium, uranium, etc. Found in pegmatites. (U. S. Geol. Surv.)

Ferraris furnace. 1. An inclined reverberatory furnace for calcining sulphide ore. (Ingalls, p. 21)
2. A gas-fired, heat-recuperative furnace for the distillation of zinc ore. (Ingalls, p. 466)

Ferraris table. An ore-concentration table consisting of a plane rubber belt traveling between rollers furnished with broad flanges to keep the belt in line. It has a slope from side to side. The feed is at the upper corner, and washing is by jets directed across the table. (Liddell)

Ferric furnace. A high, iron blast furnace, in the upper part of which crude bituminous coal is converted into coke. (Raymond)

Ferriferous. Containing iron, as rocks. (Standard)

Ferrilite. A variety of common trap; ragstone. (Standard)

Ferrite. 1. An indeterminable reddish decomposition product, in altered igneous rocks, usually consisting of hydrous iron oxide. (Standard)
2. In iron and steel, pure metallic iron. 3. Any of several compounds which may be regarded as metallic derivations of the ferric hydroxide, $Fe_2O_3(OH)_2$, analogous to aluminates. (Webster)
4. Microscopic crystals of iron oxide. (Kemp)

Ferritization. Metamorphic alteration of other material into ferrite. (Standard)

Ferroalloy. An alloy of iron with some other metal. It ordinarily refers to alloys that are used in making steels. The principal ferroalloys and the approximate percentage of the alloying metal ordinarily added are:

Ferroaluminum: Contains about 10 per cent aluminum. *Ferrocerium:* Contains from 50 to 94 per cent cerium. It is usually made from monazite residues after the extraction of thoria and, besides cerium, contains didymium, lanthanum, and other rare earth metals in smaller quantity. *Ferrochromium* or *ferrochrome:* Contains 56 to 70 per cent chromium. *Ferrocobalt:* Contains about 50 per cent cobalt. *Ferromanganese:* Only iron-manganese alloys carrying 45 per cent or more of manganese are known as ferromanganese. The iron alloys containing 7 to 45 per cent manganese are known as "spiegel" or "spiegeleisen," also as "mirror iron" or "specular pig iron." "Standard ferromanganese" contains 80 per cent manganese. Alloys containing as much as 70 per cent manganese are made in the blast furnace. The electric-furnace product contains 70 to 83 per cent manganese. "Silicospiegel" is a blast-furnace spiegeleisen carrying 17 to 22 per cent manganese and 6 to 12 per cent silicon. In European practice an alloy is made that contains 20 to 25 per cent silicon and 50 to 55 per cent manganese. *Ferromolybdenum:* Contains from 45 to 80 per cent molybdenum. *Ferronickel:* Contains 25 to 75 per cent nickel according to order. Ferronickel has seldom been used as nickel is readily soluble in molten steel, and is easily added without loss. *Ferrophosphorus:* Although not strictly an alloy is generally considered as one of the ferroalloys. It contains 10 to 25 per cent phosphorus. *Ferrotungsten:* Contains from 70 to 92 per cent tungsten. Most ferrotungsten is made in the electric furnace and ordinarily contains 70 to 82 per cent tungsten and 0.3 per cent or more carbon. The sulphur and phosphorus must be kept down to the percentage allowable in steels, *i. e.* about 0.05 per cent sulphur and about 0.05 per cent phosphorus. Ferrotungsten is also made by chemical processes, being precipitated as a powder and containing 87 to 92 per cent tungsten. *Ferrotitanium:* Contains 10 to 50 per cent titanium. "Ferrocarbon-titanium" is the trade name for the electric furnace product. That made by the alumino-thermic process is free from carbon but contains aluminum. *Ferrosilicon:* Contains 7 to 92 per cent silicon. Grades carry-

ing 7 to 16 per cent silicon are made in blast furnaces but higher silicon content is obtained only in the electric furnace. Ferrosilicon containing 85 to 92 per cent or more of silicon is used for making hydrogen gas. *Ferrovanadium:* Contains 20 to 50 per cent vanadium. Under present practice the tendency is toward 35 to 40 per cent vanadium. *Ferrouranium:* Contains between 20 and 40 per cent uranium. *Ferrozirconium:* Contains 20 to 50 per cent zirconium.

Numerous experimental alloys have been made, such as ferroboron, ferroboron-silicon ferrocobalt-chromium, ferromagnesium, ferrocalcium, ferronickel-silicon, ferrosodium and ferrotantalum, but their use has not been standardized.

There are three principal processes of making ferroalloys, viz: The blast furnace, the electric furnace, and by alumino-thermic smelting. Ferroalloys can be made in the blast furnace only when the alloy has a comparatively low melting point. The alumino-thermic process gives an alloy free from carbon but leaves some aluminum in the alloy. Either of the other processes gives alloys containing a certain percentage of carbon, though under good practice the carbon can be kept comparatively low in most ferroalloys. (Frank L. Hess.)

Ferrocalcite. A variety of calcite containing ferrous carbonate. (Dana)

Ferrocarril (Sp.). Railway, railroad; *F. aéro*, a rope way. (Halse)

Ferrogoslarite. A variety of goslarite containing ferrous sulphate. (Standard)

Ferrolite. Wadsworth's name for rocks composed of iron ores. (Kemp)

Ferromagnesian. In petrology, containing iron and magnesium. Applied to certain dark silicate minerals, especially amphibole, pyroxene, biotite, and olivine, and to ingenous rocks containing them as dominant constituents. (La Forge)

Ferromagnetic. Magnetic in a high degree, as iron, nickel and cobalt. (Webster)

Ferruginous. Containing iron. (Raymond)

Ferruginous sandstone. A sandstone rich in iron as the cementing material, or as grains, or both. (Bowles)

Ferrule. 1. A metal ring or cap on the end of a cane, handle of a tool, post, or the like, to strengthen or protect it. 2. A bushing or thimble inserted in the end of a boiler tube or the like, to spread it and make a tight joint. 3. A short pipe-coupling. (Standard)

Ferrum (L.). Iron, for which the chemical symbol is Fe.

Fetid. Having the odor of sulphureted hydrogen or rotten eggs. The odor is elicited by friction from some varieties of quartz and limestone. (Dana)

Fetid sandstone. *See* Stinkstone.

Fettle. To cover or line with a mixture of ore, cinders, etc., as the hearth of a puddling furnace. (Webster)

Fettling. 1. Material used to line the hearth of a puddling furnace, as sand, or a mixture of ore, cinder, calcined magnesite, etc. (Webster) 2. (No. of Eng.). Cleaning up any underground roadway, etc. (Gresley)

Fiador (Sp.). 1. A bondsman, surety. 2. A safety catch. 3. A supplementary rope used in a shaft for men to hold on to when ascending and descending. (Halse)

Fiasco. An ignominious failure of any kind; a complete breakdown. Said of a mining venture which has resulted in failure.

Fibra (Sp.). 1. A filament. 2. A small vein of ore. (Halse)

Fibrolite. A mineral of the same composition as andalusite which it closely resembles in crystal form, although generally in more slender crystals (Ransome). Sometimes used as a prefix to rock names. (Kemp)

Fichtelite. A white, translucent, brittle, odorless hydrocarbon from peat beds near Redwitz, North Bavaria; it is easily soluble in ether, is soluble in cold nitric acid, and distils without decomposition. (Bacon)

Fictile. 1. Molded, or capable of being molded. 2. A piece of fictile ware. (Webster)
3. Made of earth or clay; of or pertaining to pottery. (Standard)

Fiddle blocks (Scot.). Pulley blocks used for raising pump pipes, in which the pulleys are placed one above another. (Barrowman)

Fieg (Wales.). A crack in the roof, often letting in water. (Gresley)

Field. 1. A large tract or area of many square miles containing valuable minerals. *See* Coal field; *also* Mineral field. 2. A colliery, or firm of colliery proprietors. 3. The immediate locality and surroundings of a mine explosion. (Gresley) 4. A region or space traversed by lines of force; as gravitational, magnetic, or electric. (Webster)

Field-book. A book used in surveying, engineering, geology, etc., in which are set down the angles, stations, distances, observations, etc. (Century)

Field club (Eng.). A sick or accident benefit club or society supported and managed by the owners or lessees of a colliery. (Gresley)

Fieldwork. Work done, observations taken or other operations, as triangulation, leveling, making geological observations, etc., in the field or upon the ground. (Century)

Fields. (So. Afr.) A synonym for Goldfields.

Fierro (Sp.). 1. Metallic iron. 2. Matte. 3. Speiss. 4. *See* Hierro. *F. blanco*, arsenical pyrite; *F. viejo* (Peru), silver ores consisting mainly of iron oxide; *F. espejado*, specular iron ore. (Dwight)

Fierros (Mex.). 1. Low-grade silver ores (from 20 to 35 oz. per ton). 2. *Abzug* and *abstrich* from refining lead. (Dwight)

Fiery. Containing an explosive gas (*Steel*). Said of a gaseous mine.

Fiery drake; Burning drake (Derb.). A meteor much talked of by miners (1747), and said to be a sure sign of an abundance of ore at the place where it fell. (Hooson)

Fiery heap (Eng.). The deposit of rubbish and waste or unsalable coal which ignites spontaneously. (G. C. Greenwell)

Fiery mine. A mine in which the seam or seams of coal being worked give off a large amount of methane.

Fighting (Eng.). Said of a ventilating current when the motion of the air is first in one direction and then in another, due to the weight or pressure of the ventilating current of air in a mine becoming equal or nearly so in both the downcast and upcast shafts. (Gresley)

Figure stone. Same as Agalmatolite. (Webster)

Fijian soapstone. A soapstone of a Post-Tertiary age found in the Fiji Islands. (Standard)

Filite. A smokeless powder used in Italy. (Webster)

Fill (Eng.). To load trams in the mine. (Gresley)

Filled stope. A stope in which the waste rock of the vein is left on the floor of the stope, thus raising the stope as the work proceeds. (Creede United Mines Co. *v.* Hawman, 127 Pac. Rept., 924; 28 Colorado App., p. 130)

Filler (Eng.). A man who fills trams or cars at a working place or in a stall. (Gresley)

Fillet. The rounded corner of a groove in a roll used in shaping structural steel. (Raymond)

Filling. 1. (Eng.) The places where trams are loaded in the workings. (Gresley) 2. The waste material used to fill up old stopes or chambers. 3. Allowing a mine to fill with water. (Weed)

Filling deposits. A general term for deposits filling pre-existing cavities, replacing the term "crustified deposits" proposed by Posepny. (Eng. and Min. Jour., vol. 75, p. 257)

Filling-out (Aust.). Shoveling into skips and taking to the surface, as filling-out burning material when a small fire occurs in a mine. (Power)

Filling pieces. Rocks of such size as to fill the open spaces between crib timbers, etc. (Sanders, p. 116)

Filling system. *See* Sublevel stoping.

Filling-up method. *See* Overhand stoping.

Film. A coating or layer; a thin membrane; a term used in flotation. (Rickard)

Film-sizing tables. A table used in ore dressing for sorting fine material by means of a film of flowing water. These tables may be considered as surface tables, from which the products are removed before they have found a bed, so that the washing is always done on the same surface; and building tables or buddles, on which the products are removed after they have formed a bed. These use the relative transporting power of a film of water flowing on a quiet surface, which may be either rough or

smooth, to act upon the particles of a water-sorted product. The smaller grains, of high specific gravity, are moved down the slope slowly or not at all by the slow undercurrent; the larger grains, of lower specific gravity, are moved rapidly down the slope by the quick upper current. (Liddell)

Filón (Sp.). 1. A vein or lode. The Spanish use of this word is for the large veins, while *Vena* and *Veta* and their diminutives apply to the smaller veins; *F. de capa*, a bedded vein; *F. compuesto*, a compound vein; *F. de contacto*, a contact vein; *F. doble*, two veins which meet and run alongside of each other, the filling of each remaining distinct; *F. mineral*, a metalliferous vein or lode. (Halse)
2. (Mex.) A small stringer; an intersecting vein. (Dwight)
3. *F. de roca*, a dike; *F. de carbón*, a coal measure. (Halse)

Filter. 1. Any porous article, as a cloth, paper, sand, or charcoal through which water or other liquid is passed to separate from it matter held in suspension. 2. To pass through; to percolate. (Webster)

Filter bed. A pond or tank having a false bottom covered with sand, and serving to filter river or pond water. (Century)

Filtering-stone. Any porous stone, such as sandstone through which water is filtered. (Century)

Filter press. 1. A machine for removing a liquid from crushed ore (or pulp), usually by forcing the liquid under pressure through canvas or cloth, leaving the muddy ore mass behind. (Weed)
2. An apparatus employed in the separation and refining of ozokerite and paraffin wax. (Mitzakis)

Filter pump. A pump to aid filtration by producing a partial vacuum by means of a stream of water. (Webster)

Filtrar (Sp.). To filter; to sink in. (Dwight)

Filtrate. 1. To filter by straining or percolation. 2. The liquid which has passed through a filter. (Century)

Filtration. The act or process of filtering; the process of mechanically removing the undissolved particles in a liquid by passing the liquid through filtering paper, charcoal, sand, etc. (Century)

Filty (Som.). A local term for fire damp. (Gresley)

Fin. The thin sheet of metal squeezed out between the collars of the rolls in a roll train. (Raymond)

Find. 1. (Eng.) A sinking or driving for coal, etc., attended with success. (Gresley)
2. A thing found or discovered; especially, a valuable discovery; as, a find of minerals. (Standard)

Fine gold. Almost pure gold. The value of bullion gold depends on its percentage of fineness (Skinner). *See* Fineness; *also* Float gold.

Fine metal. 1. *See* Metal, 8. 2. The iron or plate metal produced in the refinery. (Raymond)

Fineness. The proportion of pure silver or gold in jewelry, bullion or coin, often expressed in parts per thousand. The fineness of United States coin is nine-tenths, or 900 fine; that of English gold coin is eleven-twelfths or 917 fine, and English silver coin is 925 fine. (Webster)

Fine raggings (Eng.). Pieces of ore deposited at the bottom of a sieve. (Hunt)

Finery. A charcoal hearth for the conversion of cast-iron into malleable iron. (Raymond)

Fines. 1. Very small material produced in breaking up large lumps, as of ore or coal. (C. and M. M. P.)
2. The product passing through the screen when the material from the zinc boxes of a cyanide mill is rubbed over a sieve. *See* Shorts. (Clennell, p. 41)
3. Small pieces of rock and dirt that fall from the mine roof, and generally, though not always, precede a falling of heavy material and consequently signify danger. (Tennessee Copper Co. *v.* Gaddey, 207 Fed. Rept., p. 299)
4. Ores in too fine or pulverulent a condition to be smelted in the same way as ordinary coarse ores. (Standard)

Finger bar. 1. (Aust.) An iron rod attached to a cage with the end bent in such a way as to keep the skips from running off the cage while being raised or lowered. (Power)
2. A prop for hanging up a stamp. (Richards, p. 199)

Finger grip. 1. (Eng.) A tool used in boring for gripping the upper end of the rods. (Gresley)
2. An instrument (tool) for recovering from a bore, as of a well, a broken rod, or dropped (lost) tool. (Standard)

Finial. Ornamental pieces of burned clay used for finishing off the joining of the ridge line with the hips, ridge line at gables, or top of a tower. (Ries)

Fining. 1. *See* Refining. 2. The conversion of cast into malleable iron in a hearth or charcoal fire. (Raymond)

Finishing jig. The jig used to save the smaller particles of ore in a concentrator or stampmill. (Weed)

Finishing rolls. 1. The rolls of a train which receive the bar from the roughing rolls and reduce it to its finished shape. (Raymond)
2 The last roll, or the one that does the finest crushing in ore dressing, especially in stage crushing.

Finos (Mex.). Fine ore; fines. (Dwight)

Fintas (Braz.). A fixed annual tax on mines. (Halse)

Fiord; Fjord. A narrow, deep, steep-walled inlet of the sea, formed by the submergence of a mountainous coast. (La Forge)

Fior di persicor. A white marble with veins and clouds of purple or red, from Albania. (Merrill)

Fiorite. Siliceous sinter, named from Mt. Santa Fiora, in Tuscany (Kemp). An opal occurring near hot springs. (Dana)

Fire. 1. To blast with gunpowder or other explosives. 2. A word shouted by miners to warn one another when a shot is fired. (Steel)
3. (Eng.). A collier's term for the explosive gas in mines. 4. To explode or blow up. The expression "the pit has fired" signifies that an explosion of fire damp has taken place. (Gresley)
5. Fuel in a state of combustion, as on a hearth, in a grate, furnace, etc. 6. In precious stones the quality of refracting and dispersing light, and the brilliancy of effect that comes from this quality. (Century)

Fire assay. The assaying of metallic ores, usually gold and silver, by methods requiring a furnace heat. It commonly involves the processes of scorification, cupellation, etc. (Standard)

Fireback. The back wall of a furnace or fireplace. (Century)

Fire bank (Mid.). A spoil bank which ignites spontaneously. (Gresley)

Fire bars. Grate bars in a fireplace. (Raymond)

Fire blende. Pyrostilpnite. (Power)

Fire board. A blackboard on which the fire boss indicates every morning, by chalk marks, the amount of gas in different parts of the mine. (Chance)

Fire boss. An underground official who examines the mine for fire damp, and has charge of its removal (Steel). *See* Fireman; *also* Fire viewer.

Fire box. The chamber of a furnace, steam boiler, etc. (Webster)

Fire breeding (So. Staff.). Said of any place underground showing indications of a gob fire. (Gresley)

Fire brick. A refractory brick of fire clay or of siliceous material used to line furnaces. (Raymond)

Fire bridge. The separating low wall between the fireplace and the hearth of a reverberatory furnace. (Raymond)

Fire chamber. The part of a furnace which contains the fuel, as in puddling furnace. (Standard)

Fire clay. A clay comparatively free from iron and alkalies, not easily fusible, and hence used for fire bricks. It is often found beneath coal beds (Raymond). Also called Bottom stone.

Fire coal (Scot.). Coal supplied to workmen connected with a colliery. (Barrowman)

Fire coat. A film of oxide on metal due to the action of fire or heat. (Webster)

Fire crack. A crack which forms in a metal while it is being reheated or annealed. (Webster)

Fire cure (Scot.). A rude kind of ventilation furnace, about 2 feet by 3 feet. (Gresley)

Fired. 1. (Eng.) Said of a mine when an explosion of fire damp has taken place. (G. C. Greenwell)
2. Said of one who has been discharged from work.

Fire damp. A combustible gas or "damp" formed by decomposition of coal or other carbonaceous matter, and consisting chiefly of methane, CH_4; also the explosive mixture formed by this gas (5.5 to 13 per cent) and air (Webster). The gas is contained in the coal and often given off in large quantities, and explodes upon ignition when mixed with atmospheric air.

Fire door. 1. The door or opening through which fuel is supplied to a furnace or stove. 2. A fireproof door in a building or in a mine, as a door to enclose an area in which there is a mine fire.

Fire engine. 1. (Scot.) A name formerly given to the steam engine. (Barrowman)
2. (Eng.) A pump worked by hand for throwing water upon gob fires. (Gresley)

Fire feeder. An apparatus for feeding the fire of a furnace. (Century)

Fire grate. The grate which holds the fuel in many forms of heaters and furnaces. (Century)

Fire-heavy (Eng.). Words marked upon the scale of a mercurial barometer to indicate when much fire damp may be expected to be given off in the mine, and to show that extra vigilance is required to keep the ventilation up to its full strength. (Gresley)

Fire hole (Scot.). A space in front of boiler furnaces to hold fuel (Barrowman). A fire box.

Fire kiln. An oven or place for heating anything. (Century)

Fire lamp (Eng.). 1. An iron basket on three legs, or hung by chains from posts, in which coal is burnt to give light to miners where gas is not used. 2. An iron bucket or basket of fire suspended in a pit-shaft (shallow mine) to create a draught or ventilation through the workings. (Gresley)

Fireman (Eng.). A man whose duty it is to examine with a safety lamp the underground workings, to ascertain if gas is present, to see that doors, bratticing, stoppings, etc., are in good order, and generally to see that the ventilation is efficient (Gresley). *See also* Fire boss.

Fire marble. *See* Lumachelle.

Fire opal. A hyacinth-red opal which gives out firelike reflections. (Dana)

Fire pan (York.). *See* Fire lamp, 2.

Fire plug. A plug or hydrant for drawing water for extinguishing fires. (Webster)

Fire point. *See* Flashing point.

Fire pot. 1. The vessel which holds the fire in a furnace. 2. A crucible. (Webster)

Fireproofing. 1. Act or process of rendering anything fireproof; also the material used in the process. (Webster)
2. A general name applied to those forms used in the construction of floor arches, partitions, etc., for fireproof buildings. (Ries)

Fire rib (So. Staff.). A solid rib or wall of coal left between workings to confine gob fires. (Gresley)

Fire setting. The softening or cracking of the working face of a lode, to facilitate excavation, by exposing it to the action of a wood fire built against it. Now nearly obsolete, but much used in hard rock before the introduction of explosives (Raymond). *See also* Firing, 4.

Fire stink. 1. (So. Staff.) The odor from decomposing iron pyrite, caused by the formation of sulphureted hydrogen. (Raymond)
2. (Eng.) Smell, indicating spontaneous combustion in a coal mine (Gresley). Also called Fire styth.

Firestone. 1. (Som.) Synonymous with Fire clay. (Gresley)
2. Iron pyrite formerly used for striking fire; also, a flint. 3. A stone which will endure high heat. 4. In a slag hearth, a plate of iron covering the front of the furnace except for a few inches of space between it and the bed plate. (Webster)

Fire styth. *See* Fire stink, 2.

Fire tile. Same as Dutch tile. (Standard)

Fire trier (Mid.). *See* Fireman; *also* Fire boss.

Fire viewer. A person whose duty it is to examine the workings of a mine with a safety lamp (Roy). A Fire boss.

Fire wall. A fireproof wall used as a fire stop. (Webster)

Firing. 1. The act of discharging a firearm, a mine, blast, etc. 2. Act or mode of introducing fuel into the furnace and working it. 3. Exposing to intense heat in a kiln. (Webster)
4. (Derb.) The application of heat by building fires upon hard strata in order to soften them, preliminary to the use of the pick. *See also* Fire setting. (Mander)

Firing a mine (Eng.). Maliciously setting fire to a coal mine. (Gresley)

Firing line (Scot.). An appliance used in former times for clearing a room of fire damp. A prop being set up near the face, a ring was fixed in it near the roof, and a cord or wire passed through the ring. Attaching his lamp to one end of the cord, the miner withdrew to a distance, and pulling the cord raised the lamp to the height necessary to explode the accumulated fire damp. (Barrowman)

Firing machine. 1. A designation for the electric blasting machine. (Du Pont)
2. An apparatus for feeding a boiler furnace with coal. A mechanical stoker.

Firing pin. A wooden cylinder upon which the blasting paper is formed in a case for the cartridge or dummy. (Steel)

Firing point (Eng.). That point at which fire damp mixed with atmospheric air explodes (Gresley). The percentages of gas vary from 6 to 13 per cent. with the maximum explosibility at about 11 per cent.

Firm (Corn.). A solid shelf of rock; bedrock (Pryce). *See also* Shelf.

Firn. A Swiss name for the granular, loose or consolidated snow of the high altitudes before it forms glacial ice below (Kemp). *See* Névé.

First aid. The assistance or treatment which should be given an injured person immediately upon injury or as soon thereafter as possible. (C. and M. M. P.)

First man (Leic.). The head butty or coal getter in a stall. (Gresley)

First-of-the-air. 1. (Ark.) That part of the air current which has just entered a mine, or working place; the intake air. 2. (Ark.) The working place of a mine, or the split, which is nearest the intake, or receives the first of the air. (Steel)

Firsts. The best ore picked from a mine (C. and M. M. P.). Heads; concentrates.

First water. The purest variety or finest quality; said of certain precious stones, especially the diamond. (Standard)

First weight (Eng.). The first movement of the roof which takes place after commencing to excavate any large area of coal, without leaving pillars. (Gresley)

First working (Eng.). Proving a seam of coal, etc., by driving headings, etc. Development work. (Gresley)

Firth. A narrow arm of the sea; a frith. (Webster)

Fish. 1. (Eng.). To catch up a drowned clack by means of a fish head. *See* Fish head. (G. C. Greenwell)
2. To join two beams, rails, etc., together by long pieces at their sides. (C. and M. M. P.)
3. To pull up or out from or as from some deep place, as if by fishing (Century). Said of recovering lost or broken well-boring tools.

Fish backs (Vt.). A local term applied to groups of closely spaced fractures in marble deposits. (Bowles)

Fish-bed. In geology, a deposit containing the fossil remains of fishes in predominant quantity among those of other marine animals. Also called Bone-bed. (Century)

Fish-bellied (Eng.). An early form of railway rail which had its greatest depth halfway between the supporting chairs (sleepers or ties), the lower edge being elliptically curved between chair and chair. Cast-iron rails were made of this form. (G. C. Greenwell)

Fish-eye stone. A synonym for Apophyllite (Chester). A hydrated calcium silicate in which part of the calcium may be replaced by potassium.

Fish head (Scot.). A tool for extracting clacks (valves) from mine pumps. (Barrowman)

Fishing. In oil-well drilling, the operation by which lost or damaged tools are secured and brought to the surface from the bottom of a well. (Mitzakis)

Fish plates. The bars used to join the ends of adjacent rails in a car track. (C. and M. M. P.)

Fish-tail bit. A bit usually employed in the rotary system of drilling. It is used for drilling in soft strata, such as sand and clay. (Mitzakis)

Fissile. Capable of being split, as schist, slate, and shale. (Roy. Com.)

Fissility. 1. Quality of being fissile. 2. A rock structure characterized by separation into parallel laminae, as slate, schist, etc. (Webster)

Fissle; Fistle (No. of Eng.). A faint crackling noise, which takes place when creep begins in the workings. (Gresley)

Fisura (Sp.). Fissure. (Dwight)

Fissure. An extensive crack, break, or fracture in the rocks. A mere joint or crack persisting only for a few inches or a few feet is not usually termed a fissure by geologists or miners, although in a strict physical sense it is one. (Ransome)
Where there are well-defined boundaries, very slight evidence of ore within such boundaries is sufficient to prove the existence of a lode. Such boundaries constitute the sides of a fissure (Iron Silver Mining Co. *v.* Cheeseman, 116, U. S. Sup. Ct. Rept., p. 536; Hyman *v.* Wheeler, 29 Fed. Rept., p. 355; Cheeseman *v.* Shreve, 40 Fed. Rept., p. 794). *See* Vein; Lode; and Fissure vein.

Fissure vein. A cleft or crack in the rock material of the earth's crust, filled with mineral matter different from the walls and precipitated therein from aqueous solution, or introduced by sublimation or pneumatolysis. (Shamel. p. 136)
A mineral mass, tabular in form, as a whole, although frequently irregular in detail, occupying or accompanying a fracture or set of fractures in the inclosing rock; this mineral mass has been formed later than the country rock, either through the filling of open spaces along the latter or through chemical alteration of the adjoining rock. (Lindgren, Genesis of Ore Deposits, p. 500)
A fissure in the earth's crust filled with mineral (Raymond). *See* Fissure; Lode; and Vein. A fissure vein or lode may have in addition to the clear fissure filling of mineral a considerable amount of decomposed wall rock, clay, etc. (Consol. Wyoming Gold Mining Co. *v.* Champion Mining Co.; 63 Fed. Rept., p. 544)

Fistle. *See* Fissle.

Fitcher (Corn.). To stick fast, as a drill. (Gillette, p. 175)

Fittage (Newc.). Expenses incurred in selling the coal. (Min. Jour.)

Fitter (Eng.). The person who sells coal at the shipping port (Bainbridge). A coal factor. *See also* Factor.

Fitting (Scot.). 1. The whole machinery, plant, and works of a colliery. (Barrowman)
2. Selling coal, as the business of a fitter. (Bainbridge)

Fitting office (Newc.). The office for the transaction of business relating to coal sales, at the shipping port. (Min. Jour.)

Fittings. A term used to denote all those pieces that may be attached to pipes in order to connect them or provide outlets, etc., except that couplings and valves are not so designated. (Nat. Tube Co.)

Fix. To fettle or line with a fix or fettling, consisting of ores, scrap and cinder, or other suitable substances, the hearth of a puddling furnace. (Raymond)

Fixation. 1. The act or process by which a fluid or a gas becomes or is rendered firm or stable in consistency, and evaporation or volatilization prevented; specifically in chemistry that process by which a gaseous body becomes fixed or solid on uniting with a solid body, as fixation of oxygen, fixation of nitrogen (Century). A state of non-volatility, or the process of entering such a state; as the fixation of a metal; the fixation of nitrogen in a nitrate by bacteria. 2. The process by which dye colors are made permanent. (Standard)

Fixed carbon. That part of the carbon which remains behind when coal is heated in a closed vessel until the volatile matter is driven off (Steel). It is the nonvolatile matter minus ash. (Webster)

Fixed rent (Scot.). The minimum yearly rent for use of a mineral field. (Barrowman)

Flag. 1. (Ches.) A bed of hard marl overlying the top stratum of a salt bed. (Gresley)
2. A thin slab of stone (Bowles). *See also* Flagstone.

Flagging. *See* Flag, 2.

Flagging a squib. Uncoiling the end of the paper which is impregnated with sulphur or some other combustible substance. Flagging the squib permits more time to elapse from the ignition of the unrolled paper and the firing of the charge of powder. (Du Pont)

Flaggy. Capable of being split into parallel-faced slabs thicker than slates. (Roy. Com.)

Flags. Thin, even beds of rocks which readily separate along the plane of deposition. They may be arenaceous, argillaceous, or calcareous. (Emmons)

Flagstone. A rock that splits readily into slabs suitable for flagging. (Bowles)

Flaikes (Scot.). Shaly or fissile sandstone (Gresley). A variation of *flake.*

Flake copper. Very thin scales of native copper. (Weed)

Flake white. A name sometimes given to pure white lead. (Ure)

Flame coloration. *See* Flame reaction.

Flame engine. A gas engine. (Century)

Flame kiln. A lime kiln that burns wood. (Standard)

Flame reaction. The characteristic coloration which certain elements or their compounds impart to a flame, thus affording a test (flame test) for their presence. (Webster)

Flame safety lamp. *See* Safety lamp.

Flame spectrum. The spectrum obtained by volatilizing substances in a nonluminous flame. (Webster)

Flamper (Derb.). Clay ironstone in beds or seams. (Gresley)

Flanch. 1. (No. of Eng.) The flange or broad ends of iron pipes where joined to one another (Gresley). *See also* Flange, 1.
2. To slant outward; to flare. (Webster)

Flang (Corn.). A two-pointed pick used by miners. (Raymond)

Flange. 1. A projecting rim, edge, lip or rib (Nat. Tube Co.). *See* Flanch.
2. (Derb.) A place where the vein turns out of its course. (Hooson)
3. Applied to a vein widening (Raymond)
4. A molder's tool for forming flanges. (Webster)
5. A plate to close a pipe opening or other orifice; a blank flange. (Standard)

Flange bolts (Newc.). Bolts for fastening pumps, or pipe flanges, together. (Min. Jour.)

Flank bore. *See* Flank hole.

Flank hole (Eng.); **Flank bore** (Scot.). A hole bored into the side of a heading or other underground working, to test the thickness of a rib or barrier, or the position of old workings likely, or known, to contain water or gas, or both. (Gresley)

Flannels (Eng.). Suits of stout white flannel clothes provided by the masters for the enginewright and his assistant for wearing in a shaft or other wet place when on repair work. (Gresley)

Flap-door (Newc.). A manhole door. (Raymond)

Flapper-topped air crossing (Eng.). An air crossing fitted with a double door or valve giving direct communication between the two air currents when forced open by the blast of an explosion. (Gresley)

Flapping. A term used in copper refining to explain the process of striking the surface of the molten metal with the edge of the head of a rabble in order to uncover the surface of the copper. (Eng. and Min. Jour., vol. 102, p. 875)

Flaps (Eng.). Rectangular wooden valves about 24 inches by 18 inches by 1½ inches thick, hung vertically to the framework of the air chambers of a ventilator (Gresley). A flap valve.

Flap valve. A valve which opens and shuts on one hinged side; a clack valve. (Webster)

Flaqueza (Peru). Leanness; shaly structure; the overhanging section of a precipice. (Dwight)

Flaser-structure. A structure developed in granitoid rocks and especially in gabbros by dynamic metamorphism. Small lenses of granular texture are set in a scaly aggregate that fills the interstices between them. It appears to have been caused by shearing that has crushed some portions more than others, and that has developed a kind of rude flow-structure. (Kemp)

Flash (Ches.). A subsidence of the surface due to the working of rock salt and pumping of brine. (Gresley)

Flashed brick. Brick that have had their edges darkened by special treatment in firing. (Ries)

Flashing. In glass making: The reheating of partially formed glassware in a flashing furnace, to restore the plastic condition and to smooth rough edges. (Century)

Flashing furnace. A furnace for reheating glass. (Century)

Flashing point; Flash point. The temperature at which petroleum, being heated, begins to evolve vapor in such quantity that on the application of a small flame a momentary flash due to the ignition of the vapor occurs. (Mitzakis)

Flash test. A test to determine the flashing point of an oil. (Webster)

Flask. 1. The wooden or iron frame which holds the sandmold used in a foundry. 2. An iron bottle in which quicksilver is sent to market. It contains 76½ pounds. (Raymond) 3. A small bottle-shaped vessel for holding fluids, especially one with a broad, flat body (Webster). A tinned vessel in which a miner carries oil for his lamp, or beverage for his lunch. (Barrowman)

Flat. 1. (Derb. and No. Wales) A horizontal vein or ore-deposit auxiliary to a main vein; also any horizontal portion of a vein elsewhere not horizontal. (Raymond) 2. (Derb.) A district or set of workings separated by faults, old workings, or barriers of solid coal. 3. (No. of Eng.) A siding or station underground; a parting. 4. (Ark.) A railroad car of the gondola type for shipping coal. (Steel) 5. A level surface, without elevation, relief, or prominences; a plain; a level tract along the banks of a river. (Webster)

Flat-back stope. An overhand stoping method in which the ore is broken in slices parallel with the levels. Also called Longwall stope. (H. C. Hoover, p. 98)

Flat coals (Scot.). Seams of coal lying horizontal or at a low angle of inclination.

Flat cut. A manner of placing the bore holes, for the first shot in a tunnel, in which they are started about 2 or 3 feet above the floor and pointed downward so that the bottom of the hole shall be about level with the floor. (Du Pont)

Flat-joint pointing. A pointing in which the mortar is flush with the surface and is lined with the point of the trowel. (Standard)

Flat lad (Eng.). Same as Craneman, 1.

Flat lode. A lode which varies in inclination from the horizontal to about 15°. *See also* Flat, 1.

Flatman (No. of Eng.). One who links (couples) the cars together at the flats, or levels. *See* Flat, 3. (Gresley)

Flat-nose shell. A cylindrical tool with a valve at the bottom, for boring through soft clay. (Raymond)

Flat of ore. A horizontal ore deposit occupying a bedding plane in the rock. *See also* Flat, 1. (Duryee)

Flat rails (Scot.). Tram rails. (Barrowman)

Flat-rods. A series of horizontal or inclined connecting rods, running upon rollers, or supported at their joints by rocking-arms, to convey motion from a steam engine or water wheel to pump rods at a distance. (Raymond)

Flat rope. A rope in which the strands are woven or sewed together to form a flat, braid-like rope. (C. M. P.)

Flats. 1. (Eng.) Subterraneous beds or sheets of trap rock or whin. 2. (No. Staff.) Tracts of coal seams which lie at a moderate inclination in districts containing highly inclined beds (Gresley). *See* Flat, 1. 3. Narrow decomposed parts of limestones that are mineralized. (C. and M. M. P.)

Flat sheet (Eng. and Aust.). A flooring of boiler plate at crossings, and at the top and bottom of a shaft, to facilitate the handling of skip, or cars (Power). Also called Flat shut; Flat sheet; Turn sheet.

Flattened-strand rope. A wire rope whose strands are flattened or oval, and therefore presents an increased wearing surface over that of the ordinary round-strand rope. (C. M. P.)

Flattened-strand triangular rope. A wire rope of the flattened-strand construction in which the strands are triangular in shape. (C. M. P.)

Flattening-furnace. A furnace in which split cylinder glass is flattened out into sheets. (Standard)

Flatter (Aust.). *See* Flatman.

Flatting (Derb.). Hauling coal underground with horses and boys. (Gresley)

Flatting mill. 1. A rolling mill for producing sheet metal. 2. A mill in which grains of metal are flattened by steel rolls, and reduced to metallic dust. (Webster)

Flat trimmer. A workman who stands in a car in which coal is being loaded from a chute, whose duty it is to pick out slate, sulphur and other impurities found in the coal (Rowden v. Kewanee Coal & Min. Co. 157, Illinois App., p. 483)

Flat vein. Same as Vein, 2, and Flat, 1.

Flat-wall (Corn.). A local term (in St. Just) for footwall. (Raymond)

Flatware. In ceramics, plates, dishes, saucers, etc., as distinguished from hollow ware. (Century)

Flat working (Scot.). A working of moderate inclination (Barrowman). *See* Flat, 1; *also* Flat lode.

Flaw. *See* Fault.

Flaxseed coal. A fine size of anthracite coal. (Webster)

Flaxseed ore. *See* Clinton ore.

Fleak (Derb.). A thatched cover to protect the miners while breaking and washing ore. (Mander)

Fleaking (Eng.). Thinning the pillars of coal before abandonment (Bainbridge). A variation of flake. *See* Flitching.

Flecha (Mex.). Machinery shafting. (Dwight)

Fleek (Mid.). Coal or other rock is said to "fleek off" when humps or masses of it fall from a slip or fault in the workings without giving warning, or without much labor in cutting (Gresley). A variation of flake.

Fleet. The movement of a rope sidewise when winding on a drum. (C. M. P.)

Fleet angle (Aust.). The angle between the two ends of a winding drum as a base, and the head frame pulley or sheave as the apex. (Power)

Fleet wheel. A grooved wheel or sheave that serves as a drum and about which one or more coils of a hauling rope pass. (C. M. P.)

Fleitman's test. A test for arsenic. It is performed in a small tube, and if arsenic is present, arsine is evolved which makes a brown stain on a paper moistened with silver nitrate. (Webster)

Flemish brick. A hard, yellow paving brick. (Standard)

Flenû coal (Belg.). A long-flame smoky variety of bituminous coal occurring abundantly in the Belgian coal fields. Similar coal is found in Wales. (Page)

Flerry. To split, as slate. (Standard)

Flete (Sp.). 1. Carriage of freight, usually freight by mules or horses. 2. Freight charges. (Halse)

Fletz (Ger. *Flötz*). A bed or stratum. As employed by Werner, a layer or bed inclosed conformably in a stratified series, but differing in character from the rocks in which it occurs. (Century)

Flexible. As applied to the characteristic of tenacity in minerals, means that the mineral will bend without breaking, and remain bent, as talc. (Dana)

Flexible joint. Any joint between two pipes that permits one of them to be deflected without disturbing the other pipe. (Nat. Tube Co.)

Flexible sandstone. A fine-grained variety of itacolumite. (Standard)

Flexible silver ore. Same as Sternbergite.

Flexure. The bending or folding of strata under lateral pressure. (Standard)

Flinders diamonds (Tasmania). A variety of topaz. (Power)

Flint. 1. A dense fine-grained form of silica which is very tough and breaks with a conchoidal fracture and cutting edges. Of various colors, white, yellow, gray, and black. *See also* Chert. (U. S. Geol. Surv.) 2. (Shrop.) Fine-grained sandstone suitable for building purposes. (Gresley)

Flint mill. 1. In pottery works, a mill in which flints are ground. 2. A device in which flints on a revolving wheel produce a shower of sparks incapable of igniting firedamp, and once used to light miners at work. (Webster). *See* Steel mill, 2.

Flintshire furnace. A reverberatory furnace with a depression, well, or crucible in the middle of the side of the hearth used for the roasting and reaction process on lead ores. (Raymond)

Flinty slate. A common slate containing more than the normal percentage of silica. (Humble)

Flitching (No. Staff.). Widening the sides of a heading. (Gresley)

Flitting (Aust.). Conveying a coal-cutting machine from one place to another. (Power)

Float. 1. The floating part of an apparatus for indicating the height of water in a steam boiler or other vessel. 2. (Scot.) Intrusive trap rock either at the surface or between strata. (Barrowman)
3. (Eng.) A clean rent or fissure in strata unaccompanied by dislocation. (Gresley)
4. A term much used among miners and geologists for pieces of ore or rock which have fallen from veins or strata, or have been separated from the parent vein or strata by weathering agencies. Not usually applied to stream gravels. Used also as an adjective.

Float-copper. 1. (Lake Sup.) Fine scales of metallic copper (especially produced by abrasion in stamping) which do not readily settle in water. (Raymond)
2. Native copper found away from its original rock. *Compare* Float ore. (Webster)

Floater; Float mineral; Float ore. The British term for float, 4, *which see.*

Float-gold; Flour gold. Particles of gold so small and thin that they float on and are liable to be carried off by the water. (Hanks)

Floating reef. Masses of displaced bed rock lying among alluvial detritus. (Lock). *See* Float, 4.

Floating spurs (Aust.). Short-lived flat quartz veins. (Power)

Float mineral. *See* Floater; Float ore.

Float ore. Water-worn particles of ore; fragments of vein material found on the surface, away from the vein outcrop (Raymond). *See* Float, 4.

Floatstone. 1. A cellular quartz rock. The honeycomb quartz detached from a lode is often called floatstone by miners. (Skinner)
2. A variety of opal that floats on water; found in light spongy concretionary or tuberous masses. 3. A bricklayer's rubbing-stone for working out the defects in a brick that has been cut. (Standard)

Flocculate. To aggregate in small lumps; said of soils and sediments (Webster). A term also used in the flotation process.

Flocculating agent. A substance which produces flocculation, as for example, the inorganic acids, and which thereby promotes settling. (Eng. Min. Jour., vol. 101, p. 431)

Flocculation. The technical term for the gathering of suspended particles into aggregations. A relative term as opposed to deflocculation. (Eng. and Min. Jour., vol. 101, p. 430)

Flocculent. Resembling wool, therefore, wooly. Coalescing and adhering in flocks. A cloud-like mass of precipitate in a solution. From *L. floccus*, a lock of wool. (Rickard)

Flock. Any small tufted or flake-like mass of matter floating in a solution, especially if produced by precipitation. (Standard)

Floe rock. A deposit of fragments of ganister situated on a steep hillside. A quartzite talus. *See* Ganister, 1. (Bowles)

Floe-till. *See* Till.

Floetz (Ger.). *See* Fletz.

Flojo (Sp.). 1. Weak, as applied to explosives. 2. *Terreno flojo*, loose or treacherous ground. (Halse)

Flood gate. 1. (Eng.) A gate to let off excess of water in flood or other times. (C. and M. M. P.)
2. A gate to regulate the flow of water as in a race way. (Standard)

Flood plain. Flat ground along a stream, covered by water at the flood stage. (Webster)

Flookan; Flooking; Fluckan; Flukan (Corn.). *See* Flucan.

Floor. 1. The rock underlying a stratified or nearly horizontal deposit, corresponding to the foot wall of more steeply-dipping deposits. 2. A horizontal, flat ore-body. 3. A floor, in the ordinary sense, or a plank platform underground. (Raymond)
4. That part of any subterraneous gallery upon which you walk or upon which a tramway is laid. (Gresley)

Floor break. The break or crack which separates a block of stone from the quarry floor. (Bowles)

Floor cut. A cut by means of which a block of stone is separated from the quarry floor. *See* Floor break. (Bowles)

Flop gate. An automatic gate used in placer mining when there is a shortage of water. This gate closes a reservoir until it is filled with water, when it automatically opens and allows the water to flow into the sluices. When the reservoir is empty, the gate closes, and the operation is repeated. (Min. Sci. Press, vol. 114, p. 369)

Flor (Mex.). The richest scrapings from the bed of an *arrastre*. (Halse)

Flora. The plants collectively of a given formation, age, or region. *Compare* Fauna. (Roy. Com.)

Floran-tin (Corn.). Tin mineral scarcely visible in the rock; also tin ore stamped very small. (Raymond)

Floridin. Fullers' earth from Quincy and Jamieson, Florida, used in decolorizing petroleum products. (Bacon)

Flos ferri. A coralloid variety of aragonite. (Power)

Flosh (Corn.). A rude mortar, with a shutter instead of a screen, used under stamps. (Raymond)

Floss. 1. Fluid, vitreous cinder, floating in a puddling furnace. (Raymond)
2. A floss hole. 3. White cast-iron for converting into steel. (Webster)

Floss hole. A tap hole. (Raymond)

Flotation. The act or state of floating, from the French *flottaison*, water-line, and *flotter*, to float, to waft. (Rickard)

Flotation process. A concentration process that takes advantage of the principles of surface tension and colloid chemistry, with whatever allied principles may be involved, to separate mineral from gangue by means of floating it upon the surface of water or other solutions, while the gangue is induced to sink through the surface and settle separately (Megraw, p. 3). The process or processes by which the valuable minerals in a mass of finely ground ore can be caused to float on a liquid into which the finely ground ore is fed. Classified as Film flotation and Froth flotation (Ralston, U. S. Bur. Mines). Among the processes are the following: Cattermole, Crilley and Everson, De Bavay, Elmore (Old Process), Elmore (Vacuum Process), Froment, Goyder and Laughton, Horwood, Hyde, Macquisten, Minerals Separation, Ltd., Murex, Potter-Delprat, Robson and Crowder, Sanders and Wolf processes.

Flötz (Ger.). *See* Fletz; Floetz.

Flour copper. Very fine scaly native copper that floats on water and is very difficult to save in milling (Weed). *See* Float copper.

Floured. The finely granulated condition of quicksilver, produced to a greater or less extent by its agitation during the amalgamation process (Raymond). The coating of quicksilver with what appears to be a thin film of some sulphide, so that when it is separated into globules these refuse to reunite. Also called Sickening and Flouring. (Roy. Com.)

Floured mercury. *See* Floured.

Flour gold. The finest gold dust, much of which will float on water. *See* Float gold. (Skinner)

Flow. 1. That which flows or results from flowing; a mass of matter moving or that has moved in a stream, as a lava-flow. 2. In ceramics, the flux used to cause color to run and blend in firing. 3. A marshy moor; a morass; low-lying watery land. (Century)

Flowage structure. A rock-texture whose appearance indicates that the material was in a state of flow immediately previous to consolidation. Called also Fluidal structure. (Standard)

Flow-and-plunge structure. A variety of false bedding, consisting of short obliquely laminated beds deposited irregularly, at various angles of slope, the result of tidal action, accompanied by plunging waves. (Standard)

Flow-bog. A peat bog of which the surface is likely to rise and fall with every increase or diminution of water, as from rains or springs. (Century)

Flow cleavage. That cleavage dependent on the parallel arrangement of the mineral constituents of the rock, developed during rock flowage. *Compare* Fracture cleavage. (C. K. Leith, U. S. Geol. Surv. Bull. 239, p. 23)

Flower of iron. *See* Flos ferri.

Flowers of sulphur. A light-yellow pulverulent sulphur formed when vapor of sulphur is condensed. (Standard)

Flowers of zinc. *See* Zinc oxide.

Flowing furnace. A reverberatory with inclined hearth, used in Cornwall for treating roasted lead ores by the precipitation process. (Raymond)

Flowing well. An oil well in which pumping is not necessary to bring the oil to the surface. (Redwood, p. 244)

Flow lines. Lines of structure in igneous rocks indicating a flowing movement of the material immediately preceding final consolidation (Standard). *See* Flow-structure.

Flow-structure. A structure due to the alignment of the minerals or inclusions of an igneous rock so as to suggest the swirling curves, eddies and wavy motions of a flowing stream. Fluxion-structure is synonymous. (Kemp)

Flucan; Fluccan (Corn.). Soft clayey matter in the vein; a vein or course of clay. (Raymond)

Flucany lode. A lode having flucan on one or both walls, and sometimes in the center. (Power)

Flue. 1. A passage for air, gas, or smoke. (Raymond)
2. A British term used in the same sense as the term Tube is used in America. (Nat. Tube Co.)
3. (So. Wales). A furnace, as a large coal fire at or near the bottom of an upcast shaft for producing a current of air for ventilating the mine. (Gresley)

Flue bridge. The separating low wall between the flues and the laboratory of a reverberatory furnace. (Raymond)

Flue brush. A brush made of pieces of wire or steel used to cleanse the interior of a flue from scales and soot. (Century)

Flue cinder. Iron cinder from the reheating furnace, so called because it runs out from the low r part of the flue. (Raymond)

Fluedust. Dust composed of particles of unchanged or oxidized ore, volatized lead that has been converted into oxide, carbonate and sulphate, and of fuel (Hofman, p. 85). It may also include other volatilized products, as of arsenic, zinc, etc.

Flue linings. Low-grade fire-clay pipe of cylindrical or rectangular cross section used for lining flues. (Ries)

Flue plate; Flue sheet. A tube plate in a boiler for supporting the ends of the flue pipes. (Webster)

Flue sheet. *See* Flue plate.

Flue tops. A form of burned clay ware, often of ornamental character, placed on the top of chimney flues. (Ries)

Fluid. Having particles which easily move and change their relative position without separation of the mass, and which easily yield to pressure; capable of flowing; liquid or gaseous. (Webster)

Fluidal structure. The arrangement of mineral particles in an igneous rock caused by a movement or flow in the mass when it was but partially crystallized (Century). Also called Fluxion-structure, and Flow-structure.

Fluidimeter. An instrument devised by H. Joshua Phillips for determining the fluidity of oils at various temperatures. (Mitzakis)

Fluid inclusion. A liquid inclosed in a cavity, usually very minute, in a mineral. (Century)

Fluid ton. Thirty-two cubic feet. A unit to correspond with the short ton of 2,000 lbs., and of sufficient accuracy for many hydro-metallurgical, hydraulic and other industrial purposes, it being assumed that the water or other liquid under consideration weighs 62.5 lb. per cubic foot. (Eng. and Min. Jour., Jan. 4, 1919)

Flujo (Sp.). Flux. (Halse)

Flukan. Same as Flucan.

Fluke. A rod used for cleaning drill holes before they are charged with powder. (Davies)

Flume. 1. An inclined channel usually of wood and often supported on a trestle, for conveying water from a distance to be utilized for power, transportation, etc., as in placer mining, logging, etc. 2. A mill tail. 3. A ravine or gorge with a stream running through it. 4. To trans-

port in a flume, as logs. 5. To divert by a flume, as the waters of a stream, in order to lay bare the auriferous sand and gravel forming the bed.

Fluming. *See* Flume, 4 and 5.

Fluor. A synonym for Florite. *See* Fluorspar.

Fluorapatite. Common apatite, containing fluorine with but little or no chlorine. (Webster)

Fluorescence. The emission of light from within a substance while it is being exposed to direct radiation, or, in certain cases, to an electrical discharge in a vacuum tube. (Dana)

Fluorine. An element of the chlorine family, isolated as a pungent, corrosive gas, pale greenish-yellow in color. Symbol, F; atomic weight, 19.0; specific gravity, 1.31. (Webster)

Fluorine minerals. Minerals containing fluorine, such as apatite, amblygonite, chondrodite, cryolite, fluorite, lepidolite, topaz, and others. (A. F. Rogers)

Fluorite. *See* Fluorspar.

Fluorspar; Fluorite. The mineral calcium fluoride, CaF_2. Color commonly purple, green, or white (U. S. Geol. Surv.). It is the fourth in the scale of hardness, or next higher than calcite, and may be scratched by a steel point.

Fluran. *See* Floran-tin.

Flush. 1. To operate a placer mine, where the continuous supply of water is insufficient, by holding back the water and releasing it periodically in a flood. 2. To fill underground spaces, as in coal mines, with material carried by water, which after drainage forms a compact mass. (Webster)
3. To clean out a line of pipes, gutters, etc., by letting in a sudden rush of water. 4. The splitting of the edges of stone under pressure. 5. Forming an even continuous line or surface. (C. and M. M. P.)
6. (Mid.) A small flash due to ignited fire damp. (Gresley)
7. *See* Hydraulic mine-filling.

Flush production. The yield of an oil well during the early period of production. (Redwood, p. 243)

Fluthwerk (Ger.). Searching for ore in streams and river beds. (Davies)

Fluting. A smooth, gutter-like channel or deep smooth furrow worn in the surface of rocks by glacial action. (Roy. Com.)

Fluvial. Of, or pertaining to rivers; growing or living in streams or ponds; produced by river action, as a fluvial plain. (Webster)

Fluviatile. Growing near or belonging to rivers or fresh water; caused or produced by the action of a river; fluvial. (Standard)

Fluviatile deposits. Sedimentary deposits laid down by a river or stream. (Ransome)

Fluvioglacial. Produced by streams which have their source in glacial ice. (Webster)

Fluvio-marine. Formed by the joint action of a river and the sea, as in the deposits at the mouths of rivers. (Thompson)

Fluvioterrestrial. Of or pertaining to the land and fresh waters of the earth; not marine. (Standard)

Flux. 1. A salt or other mineral, added in smelting to assist fusion, by forming more fusible compounds. (Raymond)
2. Bitumens, generally liquid, used in combination with harder bitumens for the purpose of softening the latter. *See* Asphaltic fluxes; Paraffin fluxes. (Bacon)

Fluxing ore. An ore containing an appreciable amount of valuable metal, but smelted mainly because containing fluxing agents required in the reduction of richer ores. (Weed)

Fluxion structure. Same as flowage structure. A structure that includes such phenomena as flow-lines, parallel orientation of phenocrysts, banding, elongation of vesicles, etc. (Standard). *See* Fluidal structure.

Flux-spoon. A small ladle for dipping up a sample of molten metal for testing. (Century)

Fly. 1. (Mont.) A gate or door in a hopper for diverting ore, rock, or coal from one bin or conveyor to another. 2. A piece of canvas drawn over the ridge-pole of a tent, doubling the thickness of the roof, but not in contact with it except at the ridge-pole. 3. The flap or door of a tent. (Century)

Fly doors (No. of Eng.). Doors in working roadways, opening either way. (Gresley)

Flying cradle (Eng.). *See* Cradle, 1 and 2.

Flying reef (Aust.). A broken, discontinuous, irregular vein. (Power)

Foach (Eng.). Nearly synonymous with the old Cornish word, "Pock," "Pokkin," to push. A narrow level is called a "Foching little level." When a miner has not obtained what he considers a full price for his contract he would be likely to say, "'Twill do 'pon a foach," *viz.* it will do on a push. (Hunt)

Foal (Newc.). A young boy employed in putting coal. (Raymond)

Foaley bant (Derb.). A group of three or four boys sitting in chain loops attached to a hemp rope a few feet above the heads of a group of men (also riding in chains attached to the same rope) in which position they formerly rode up and down a mine shaft. (Gresley)

Foam. A collection of minute bubbles resulting from strong agitation of a liquid (Standard). A term used in the flotation process, meaning to froth; to foam.

Foaming earth. A synonym for Aphrite (Chester). *See* Earth foam.

Foam-spar. Same as Aphrite.

Foco (Mex.). Electric arc or incandescent lamp. (Dwight)

Fodder. 1. (No. of Eng.) A unit employed in expressing weights of metallic lead, and equal to 21 hundredweight of 112 pounds avoirdupois. (Raymond)
2. Eight pigs of cast iron. (Webster)

Foddom; Faddum (Scot.). Fathom.

Fogaña de horno (Peru). The fire pit of a furnace. (Dwight)

Fogata (Mex.). Fumes from blasting. (Dwight)

Foge (Corn.). A forge for smelting tin. (Raymond)

Fogón (Sp.). A hearth; fire box. (Dwight)

Fogonero (Mex.). A boiler-fireman. (Dwight)

Foil. Metal, in very thin pliable sheets or leaves; as, tin foil; gold foil. (Standard)

Foil-stone. An imitation jewel. (Century)

Fold. Rocks or strata which have been bent into domes and basins or rolls. This structure is observed mainly in mountainous regions, and is characteristic of both the altered and unaltered sedimentary rocks (Buckley). Strictly, a strong flexure of a stratum, with steeply inclined sides. Loosely and more commonly any flexure of a stratum. (Standard)

Folding boards (Scot.). Shuts; a shifting frame on which the cage rests, in or at the top of a shaft (Barrowman). Chairs; dogs; keeps; keps.

Foliated. Leaf-like. The meaning is similar to that of laminated, but the latter generally indicates a finer or more parallel division into layers, foliated being applied rather to the approximate parallelism of the layers in such rocks as gneiss and schist. (Roy. Com.)

Foliated coal. Coal occurring in thin plates or layers.

Foliates. A term suggested by Bastin as a convenient and comprehensive one to include all rocks showing foliated structure other than bedding planes. (Watson)

Foliation. 1. The banding or lamination of metamorphic rocks as distinguished from the stratification of sediments. (Kemp)
2. A crystalline segregation of certain minerals in a rock, in dominant planes, which may be those of stratification (stratification-foliation) of joints (joint-foliation), of shearing (cleavage-foliation), or of fracture under the strain of flexure (faulting-foliation). (Standard)

Folkstone marl (Eng.). A stiff marl, varying in color from light gray to a dark blue; also known as gault. It abounds in fossils. (Humble)

Follower. A drill used for making all but the first part of a hole, the latter being made with a drill of larger gauge, known as a starter. (Bowles)

Following (Scot.). An overlying stratum which falls or comes down as the mineral is extracted from under it. (Barrowman)

Following dirt (Lanc.). A thin bed of loose shale, etc., forming the roof of a coal seam, which has to be taken down in the workings in order to prevent it falling. (Gresley)

Following-in (Eng.). Said of a shift arriving at a working place before the previous shift has finished work. (Gresley)

Following stone. Roof stone that falls on the removal of the seam (C. and M. M. P.). *See* Following.

Following-up bank (York.). A breadth of about 6 yards of coal taken off the working face. (Gresley)

Following-up-the-whole with the broken. *See* Bord-and-pillar method.

Follow-up tag. The cardboard tag placed in the cartons, boxes, or cases of blasting supplies, used for identifying the date and place of manufacture. (Du Pont)

Fomento (Sp.). Protection, support, encouragement; *Junta de F. y administración*, board of encouragement and administration of mining. (Halse)

Fondeo (Mex.). Temporary staging in a shaft. (Dwight)

Fondo. 1. (Mex.) Bottom, as of a mine. (Dwight)
2. (Sp.) Underground workings. 3. (Bol.) An amalgamating pan. (Lucas)

Fondón (Sp.) A wooden or stone tub or kettle with a copper bottom, used for grinding and amalgamating silver ores (Standard). A large copper vessel, in which hot amalgamation is practiced. (Raymond)

Fonolita (Sp.). Phonolite. (Dwight)

Fontaine powder. A variety of picrate powder containing potassium chlorate. (Webster)

Fool's gold. Pyrite, a sulphide of iron, FeS_2.

Foot. 1. A measure of 12 inches; one-third of a yard. (Webster)
2. (Corn.) An ancient measure containing 2 gallons or 60 lbs. of black tin. (Davies)
3. The footwall.
4. A "foot" is twelve inches in length on the vein, including its entire width, whether six inches or sixty feet, and its whole depth down toward the earth's center. (Standard)

Foot-acre. *See* Acre-foot.

Footage. The payment of miners by the running foot of work (Standard). *Compare* Yardage, and Cordage.

Foot ale (Derb.). Ale bought with the first day's wages after a man begins work. All the miners join in a jollification. (Hooson)

Foot blocks (Eng.). Flat pieces of wood placed under props, in tunneling, to give a broad base, and thus prevent the superincumbent weight from pressing the props down. (Simms)

Foot-hill. A distinct lower part of a mountain; one of the hills or minor elevations of a mountain range which lie next the adjacent lower land and form a transition between that and the higher portions. Commonly used in the plural. (Century)

Foot hole. Holes cut in the sides of shafts or winzes to enable miners to ascend and descend. (C. and M. M. P.)

Foot-hook (So. Staff.). The large hoisting-rope hook that is attached to the skip. (Min. Jour.)

Foot-hook chain (So. Staff.). A strong chain at the end of the rope, and connected with the foot-hook. (Min. Jour.)

Footing. A spreading course or courses forming the foot or foundation of a wall. (Standard)

Foot-piece. *See* Sill, 2.

Foot-pound. A unit of energy, or work, being equal to the work done in raising one pound avoirdupois against the force of gravity the height of one foot. (Webster)

Footrill; Futteril; Footrail. 1. (Eng.) The entrance to a mine by means of a level driven into a hillside. An adit. 2. A dip road, up which coal is brought. (Gresley)

Foot rod (Scot.). An iron rod at the foot of pump rods to which the bucket is attached. (Barrowman)

Footwall (Corn.). The wall under the vein (Raymond). Sometimes called Underlying wall.

Footway. The series of ladders and platforms by which men enter or leave a mine (Raymond). Also a footpath along a haulage way.

Foralite. A marking formed in sandstone and other formations, possibly due to the burrowing of a worm; a boring in a stone. (Standard)

Forbesite. A dull grayish-white, hydrous nickel-cobalt arsenate, $H_2(Ni,Co)_2As_2O_8+8H_2O$, having a fibrocrystalline structure. From Atacama. (Dana)

Forced production. To work a mine so as to make it produce a greater output than can be maintained. (Milford)

Force fan. A blowing fan.

Force piece. Timber placed diagonally across a shaft or drift for securing the ground. (Davies)

Force pump. A pump that forces water above its valves. (C. and M. M. P.)

Forcer. 1. A small hand-pump used in Cornish mining. 2. The solid piston of a force-pump. (Standard)

Forcherite. An orange-yellow opal colored with orpiment. (Standard)

Forcing lift; Forcing set (Scot.). A set of pumps raising water by a plunger; a ram pump. (Barrowman)

Forcing set (Eng.). A force pump. *See* Forcing lift.

Fore bay. A reservoir or canal from which water is immediately taken to run a water wheel, a turbine, or the like. The discharging end of a pond or millrace. (Webster)

Forebreast (Scot.). The working face of a mine. (Barrowman)

Forechamber. An auxiliary combination for gas-fired boilers, that provides incandescent surface for lighting gas instantly when turned on after being shut off for any reason. Also called Dutch oven and Dog house. (Willcox)

Forefield (Newc.) The face of the workings. The forefield-end is the end of the workings farthest advanced. (Raymond)

Forefield end (Derb). The farthest extremity of mine workings. (Min. Jour.)

Forehammer (Scot.). A sledge hammer; commonly applied to the hammer used by a blacksmith's assistant. (Barrowman)

Forehead (Scot.). The face of a mine or level. (Barrowman)

Foreheadway (Eng.). *See* Headway, 1.

Forehearth. A projecting bay in the front of a blast-furnace hearth, under the tymp. In open-front furnaces it is from the forehearth that cinder is tapped. *See* Dam, 3, and Tymp, 1 (Raymond). An independent settling reservoir into which is discarded the molten material from the furnace, and which is heated from an independent source. The heavy metal settles to the bottom and the light slag rises to the surface. (Peters, p. 298)

Foreland. A promontory or cape; a headland. (Century)

Forellenstein. A variety of olivine-gabbro, consisting of plagioclase, olivine and more or less pyroxene. The dark silicates are so arranged in the lighter feldspar as to suggest the markings of a trout (from the German, *Forelle.*) (Kemp)

Foreman. A leader; the chief of a set of workmen who superintends the rest; an overseer. (Webster) *See also* Bank boss.

Fore mine; Fore-set mine (Scot.). A mine (entry or room) driven toward the rise of the strata. (Barrowman)

Forepale; Forepole. To drive timbers or planks horizontally ahead at the working face, to prevent the caving of the roof in subsequent driving (Raymond). *See* Forepoling.

Forepole. *See* Forepale.

Forepoling. A method of securing drifts in progress through quicksand by driving ahead poles, laths, boards, slabs, etc., to prevent the inflow of the quicksand on the side and top, the face being protected by breastboards (Raymond). *See also* Forepale.

Fore-set beds. The series of inclined layers accumulated as sediment rolls down the steep frontal slope of a delta. *See* Bottom-set beds, and Top-set beds. (Watson, p. 274)

Fore shift (Eng.). The first shift of hewers (miners) who go into the mine from 2 to 3 hours before the drivers and loaders. (G. C. Greenwell)

Foresight. 1. Any reading taken to determine the elevation of a point on which a leveling rod is held; better called minus sight, since it must be subtracted from the elevation of the line of sight to give the elevation of the point. 2. Any sight or bearing taken in a forward direction by a compass or transit. (Webster)

Foresite. A zeolitic mineral from the Island of Elba. It resembles stilbite. (Century)

Fore-spar plate. *See* Bloomery.

Forest marble. An argillaceous limestone which when cut along certain planes shows the dark coloring matter so distributed as to be imitative of woodlands and forests; also called Landscape marble. (Merrill)

Forestop. (Derb.). To forepole.

Forewinning (Newc.). The first working of a seam in distinction from pillar drawing (C. and M. M. P.). Advance workings.

Forfeiture. Loss of some right, privilege, estate, etc., in consequence of some breach of condition, or other act. The act of forfeiting. (Webster)

Forfeiture of a mining claim takes place by operation of the law without regard to the intention of the locator whenever he fails or neglects to preserve his right by complying with the conditions imposed by law, and is made effectual by one who enters upon the ground after the expiration of the time within which the annual labor may be done, and completes a location before resumption of work by the original locator (Street *v.* Delta Min. Co., 42 Montana, p. 386). A forfeiture of a mining claim consists in the consequence attached by law to certain facts, and the intention of the claimant as to whether or not a forfeiture in fact exists is wholly immaterial, and in this respect a forfeiture differs from abandonment (Navajo Indian Res. In re, 30 L. D., p. 515; U. S. Min. Stat., pp. 254–258). *Compare* Abandonment.

Forge. 1. An open fireplace or hearth with forced draft, for heating iron, steel, etc.; as, a blacksmith's forge. 2. A hearth or furnace for making wrought iron directly from the ore; a bloomery. (Standard)
3. (Eng.) That part of an ironworks where balls are squeezed and hammered and then drawn out into puddle-bars by grooved rolls. (Raymond)
4. To form by heating in a forge and hammering; to beat into some particular shape, as a mass of metal. (Century)

Forge cinder. The dross or slag from a forge or bloomery. (Webster)

Forgemaster. The owner or superintendent of a forge or iron-works. (Century)

Forge roll. One of the train of rolls by which a slab or bloom of metal is converted into puddled bars. (Century)

Forge scale. A loose coating of oxide which forms on heated iron during the process of forging; hammer scale. (Standard)

Forge train. In iron-puddling, the series of two pairs of rolls by means of which the slab or bloom is converted into bars. (Century)

Forging. A piece of forged-metal work; a general name for pieces of hammered steel. (Century)

Forging-press. A press for forging small metal articles. (Century)

Fork. 1. (Corn.) The bottom of the sump. 2. (Derb.) A piece of wood supporting the side of an excavation in soft ground. (Raymond)
3. A tool with many tines or prongs used for separating lump coal from slack. (Steel)
4. (Scot.) A tool used for changing buckets. (Barrowman)
5. A prop with a Y-shaped end. (Skinner)
6. An appliance used in freefall systems of drilling which serves to hold up the string of tools during connection and disconnection of the rods. (Mitzakis)
7. (Eng.) To pump water out of a mine. A mine is said to be "in fork," or a pump "to have the water in fork," when all the water is drawn out of the mine. (Webster)

Fork-filled (Aust.). Coal filled into skips with a fork, having the prongs about 1¼ inches apart. This separates the bulk of the slack from the round coal, which should not contain more than 10 per cent of fine coal. (Power)

Form. 1. All the faces of a crystal which have a like position relative to the planes, or axes, of symmetry (Dana). The sum of those planes whose presence is required by the symmetry of crystal when one of them is present. (Standard)
2. A mold, pattern, or model; something to give shape, or on or after which things are fashioned. 3. A blank or schedule to be filled out by the insertion of details. (Century)

Formación. 1. (Sp.) Formation. 2. (Colom.) Altered country rock forming the filling of a lode. Analogous to "mullock" of Australia. (Halse)

Formal (Mex.). Regular; undisturbed. (Dwight)

Formalizar (Mex.). To formalize a contract or other legal paper. (Dwight)

Formation. As defined and used by the U. S. Geological Survey, the ordinary unit of geologic mapping consisting of a large and persistent stratum of some one kind of rock. It is also loosely employed for any local and more or less related group of rocks. In Dana's Geology it is applied to the groups of related strata that were formed in a geological period (Kemp). Any assemblage of rocks which have some character in common, whether of origin, age or composition (Lyell). In chronological geology formations constitute as it were the units, and several formations may go to make up a system. The word is often loosely used to indicate anything which has been formed or brought into its present shape. (Roy. Com.)

Formene. Methane. (Standard)

Formosa marble. A high grade of marble of a dark-gray and white color variously mottled and blotched with yellow and red; from Nassau, Germany (Merrill)

Formula weight. The sum of the atomic weights of the elements of a compound.

Forno (Port.); **Horno** (Sp.). 1. An oven or kiln. 2. A furnace; *F. alto*, a blast furnace. (Halse)

Forro (Mex.). Lagging. (Dwight)

Forsterite. A magnesium silicate mineral, Mg_2SiO_4, occurring in white crystals at Vesuvius; in greenish or yellowish embedded grains at Bolton, Mass., as boltonite. (Dana)

Fósforo (Sp.). Phosphorus. (Dwight)

Fosil (Sp.) 1. Fossil. 2. Any mineral or rock. (Halse)

Fosilifero (Sp.). Fossiliferous. (Dwight)

Fosse (Fr. and Belg.). Literally, a ditch, moat, or trench. Frequently applied to a colliery or coal mine. (Gresley)

Fossick. 1. (Aust.). To work out the pillars of abandoned claims, or work over waste heaps in hope of finding gold. (Standard)
2. (Eng.) In gold mining to undermine another's digging. 3. A troublesome person. (Century)

Fossicker (Aust.). A sort of mining gleaner who overhauls old workings and refuse heaps for gold that may be contained therein. (Davies)

Fossil. 1. Originally, any rock, mineral, or other object dug out of the earth. 2. Now, any remains, impression, or trace of an animal or plant of past geological ages which have been preserved in a stratified deposit or in a cave. (Webster)
3. (Mid.) A local term formerly used for a particular kind of rock bed found in sinking. Cank, lignite, etc., were called by this name. (Gresley)

Fossil copal. *See* Copalite

Fossil farina. *See* Bergmehl, 2.

Fossil flour. Infusorial earth. (Century)

Fossil glacier. A remnant of the Pleistocene ice-sheet on the coastal plains of northern Siberia. It is covered by soil and vegetation, interbedded with clays, and in the ice are found the carcasses of the mammoth and the hairy rhinocerous, retaining flesh, skin and hair. (Century)

Fossiliferous. Containing organic remains. (Comstock)

Fossilize. 1. To reduce to a fossil; convert into a fossil. 2. To become antiquated or obsolete. (Century)

Fossil ore. Fossiliferous red hematite. (Raymond)

Fossil paper. *See* Mountain paper.

Fossil resin. A resin found in a geological deposit, as amber and copalin. (Standard)

Fossil salt. Same as rock salt. (Century)

Fossil wax. *See* Ozocerite.

Fother (No. of Eng.). 1. A measure of coal (17¾ cwt.), being an ordinary cartload for one horse. (Gresley)
2. A weight by which lead and some other metals were formerly sold, in England, varying from 19 to 24 cwt., and divided in 30 fotmals. (Webster)

Fotmal (Eng.). An old weight for lead, etc., usually about 70 pounds. *See* Fother, 2. (Webster)

Foucault current. In electricity, an eddy current. (Webster)

Foul. A condition of the atmosphere of a mine, so contaminated by gases as to be unfit for respiration (Gresley). Impure.

Foul coal (Eng.). Faulty, or otherwise unmarketable coal. (Gresley)

Foulness. 1. (Scot.) An impurity in a seam; an irregularity in the physical character of a seam, caused, *e. g.*, by numerous lypes or small hitches. (Barrowman)
2. (Eng.) Fire damp.

Fouls (Eng.). A condition in which seams of coal disappear for a certain space and are replaced by some foreign matter (Gresley). *See* Fault, 2.

Found. 1. (Eng.) When sinking or driving to find or prove a coal seam, as soon as it is encountered it is said to have been found. (Gresley)
2. To form in a mold, as articles of cast iron, by melting the metal and pouring; to cast. (Standard)

Foundation. 1. A structure upon which a building or machine is erected, usually wholly or principally of masonry; that part of the building below the surface of the ground, or the portion that constitutes the base; sometimes a platform on which the upper portions rest. (Standard)
2. (Mid.) The shafts, machinery, building, railways, workshop, etc., of a colliery, commonly called a plant. (Gresley)

Founder. 1. (Eng.). The first shaft sunk upon a vein. From this the miner possesses, and lays out, his ground. (Hunt)
2. One who practises the business of founding; one who makes castings; as, an iron-*founder*. (Standard)

Foundermere (Derb.). The first 32 yards of ground worked. (Min. Jour.)

Foundershaft. The first shaft sunk (Raymond). *See also* Founder, 1.

Founders shares. The few shares issued to the individuals organizing a stock company. In companies owned outright by other companies, founders shares are issued to as many individuals as are required to incorporate and hold the offices required for corporate management, as the laws do not permit a corporation, which is an artificial person, to form another corporation, or to serve as a director of another corporation. (Weed)

Founding. The act or process of casting metals. (Century)

Foundry. A manufacturing establishment in which articles are cast from metal: as, an iron *foundry;* brass *foundry*. (Standard)

Foundry iron. A dark grade of pig iron, rich in carbon, used for making castings. (Webster)

Fountain. A spring of water issuing from the earth. The source or head, as of a river (Webster). *See also* Gusher.

Fourchite. In petrology, an aphanophyric, basalt-like igneous rock containing phenocrysts of augite in a groundmass composed of hornblende, augite, and analcite, but no olivine. (La Forge)

Fourling. A twin crystal consisting of four individuals. (Standard)

Four-wheel jimmie (Penn.). A four-wheel railroad car made of wood. It was the first type of car made for the transportation of anthracite. (Nicolls)

Fowlerite. A zinc-bearing variety of rhodonite. (A. F. Rogers)

Fox mold (Eng.). A provincial name for the reddish greensand colored by an oxide of iron. (Roberts)

Foxtail. 1. (So Wales). The last cinder obtained in the Welsh process of refining iron in a charcoal forge. (Standard)
2. A grass, with sharp barbed seed, common in mining regions of California and other western States.

Fox wedge (Eng.). A long wedge driven between two other wedges with their thick ends placed in the opposite directions. It is also called stob-and-feather, or plug-and-feather. (G. C. Greenwell)

Foyaite. A variety of nephelite, syenite, containing hornblende, from Mt. Foya in the Monchique range of Portugal. (Kemp)

Fractile. Pertaining to cleavage or breakage, as in stone. (Standard)

Fractional distillation. An operation for separating a mixture of two or more liquids which have different boiling points (Century). Used extensively in petroleum distillation.

Fractionate. To separate (a mixture, as a liquid by distillation) into fractions having more or less fixed properties but not necessarily definite compounds; applied also to mixtures of rare earths. (Standard)

Fractionation. Chemical or physical separation by successive operations, each removing from a liquid some proportion of one of the substances. The operation may be one of precipitation, or of crystallization, or of distillation. (Century)

Fractura (Sp.). Fracture. (Dwight)

Fracture. The character or appearance of a freshly broken surface of a rock or mineral. Peculiarities of fracture afford one of the means of distinguishing minerals and rocks from one another. (Roy. Com.)

Fracture cleavage. The capacity to part along parallel planes, usually in intersecting sets, along which there has been either incipient fracturing or actual fracturing followed by cementation or welding. This structure is developed in shearing planes. It may or may not be accompanied by a parallel arrangement of mineral. *Compare* Flow cleavage. (C. K. Leith, U. S. Geol. Surv., Bull. 239, p. 139)

Fragmental. Formed from fragments of preexisting rocks, such as sandstones and breccias. Clastic is synonymous. (Kemp)

Fragua (Sp.). Forge; blacksmith's shop. (Dwight)

Fraidronite. A name used by early French geologists for a variety of minette. (Kemp)

Frame; Rack (Eng.). A table composed of boards slightly inclined, over which runs a small stream of water to wash off waste from slime tin (Hunt). A buddle. *See* Tin frame.

Frame dam (Eng.). A solid, watertight stopping or dam in a mine to keep back and resist the pressure of a heavy head of water. (Gresley)

Frame set. The legs and cap or cross-bar arranged so as to support the roof of an underground passage. Also called Framing or Set. (Steel)

Frame table. An inclined table, used in separating ore slimes by running water; a miner's frame. (Standard)

Frame tubbing (Eng.). Solid wood tubbing, entirely composed of rings or curbs of wood about 6 by 8 inches square built up in segments, and wedged to keep it watertight. (Gresley)

France screen. A traveling-belt screen in which the screencloth is mounted on a series of separate pallets, thus avoiding bending the screen as it goes over the pulleys. (Liddell)

Francisci furnace. A furnace for the treatment of roasted blende and other fine ore. It consists of a series of superimposed muffles formed by arches of magnesia brick and built into the walls of the furnace and communicating with a common condensation chamber. (Ingalls, p. 485)

Frangibility. The degree of facility with which a rock can be broken, or yields to the hammer. (Oldham)

Franja (Port.). Paystreak. (Halse)

Franjilla (Peru). Argentiferous galena. (Halse)

Franklinite. An iron-manganese-zinc oxide mineral, $(Fe, Zn, Mn)O.(Fe, Mn)_2O_3$. (U. S. Geol. Surv.)

Frasch process. 1. A desulphurizing process which consists of distilling oil over lead oxide, followed by refining with sulphuric acid. (Mitzakis)
2. A process for mining sulphur in which superheated water is forced into the sulphur deposits, for the purpose of melting the sulphur. The molten sulphur is then pumped to the surface. Used extensively in Louisiana and Texas.

Free. 1. Native, uncombined with other substances, as free gold or silver. (Raymond)
2. Coal is said to be "free" when it is loose and easily mined, or when it will "run" without mining. (Chance)

Free air. Ordinary air at sea level and at a temperature of 60° F. (Gillette, p. 213)

Free-burning coal. Coal which does not cake when burning. (Bacon)

Free cleek (Scot.). The right of a miner to get hutches (cars) without waiting his turn. (Barrowman)

Free coal. 1. (Scot.) Coal on which lordship or royalty is not paid. 2. (Scot.) Coal easily broken or which burns freely (Barrowman). *See also* Free-burning coal.

Free crushing. Crushing under conditions of speed and feed such that there is plenty of room for the fine ore to drop away from the coarser part and thereby escape further fine crushing. *See also* Choke crushing. (Richards, p. 98)

Free-drainage level. An adit. A level which drains through an adit. (Gresley)

Free fall. 1. An arrangement by which, in deep boring, the bit is allowed to fall freely to the bottom at each drop or down-stroke. (Raymond)
2. The process of operating the drill. Often called Russian, Canadian, and Galician free fall.

Free-flowing volcano. One in which the flow is moderately constant with a minimum of violence. (Standard)

Free gold. Gold uncombined with other substances (Skinner). Placer gold.

Freeing a mear (Eng.). The giving of the first dish of ore to the lord (owner) of the mine. (Hunt)

Freeing of ore (Derb.). Cutting out soft material from one side of the vein in order to make it easier to mine the ore. (Hooson)

Free level (Eng.). An adit. (C. G. Greenwell)

Free-milling. Applied to ores which contain free gold or silver, and can be reduced by crushing and amalgamation, without roasting or other chemical treatment. (Raymond)

Free miner. 1. (Can.) A person or association holding a license and thereby authorized to prospect on unoccupied lands and to carry on mining operations subject to any other conditions imposed by the law. A licensed miner. (Webster)
2. (Forest of Dean) A man born within the Hundred of St. Briavels, in the county of Gloucester, who has worked a year and a day in a mine. (Gresley)

Free share (Som.). A certain proportion of a royalty on coal, paid to lessor by lessee. (Gresley)

Freestone. Any stone, especially a sandstone, that may be cut freely in any direction without a tendency to split.

Free way. A direction of easy splitting in a rock. (Bowles)

Freeze. To solidify, as of a molten charge in a furnace. (Weed)

Freiberg amalgamation. *See* Barrel process.

Freibergite. A silver-rich tetrahedrite. *See* Tetrahedrite. (U. S. Geol. Surv.)

Freieslebenite. A lead-silver sulphantimonide mineral, approximately $5(Pb,Ag_2)S.2Sb_2S_3$. Contains 24.5 per cent silver (U. S. Geol. Surv.)

French blue. *See* Ultramarine, 2.

French chalk. A kind of talc used by tailors. (A. F. Rogers)

Freno (Sp.). 1. A bridle. 2. A brake on a hoist; *F. de seguridad*, a safety brake. (Halse)

Frente (Mex.). Breast of working or face of drift; *F. de guia*, main or haulage level in a mine. (Dwight)

Frenzied (So. Staff.): Said of coal crushed by the creep or subsidence of the cover. (Gresley)

Fresh air. Air free from the presence of deleterious gases (Roy). Pure air.

Freshet. A sudden rise in a stream or river, caused by heavy rains or melting snow in the mountains or highlands, and which does great damage to the works connected with hydraulic mining unless guarded against in time. (Milford)

Freudenberg plates. Iron plates suspended in dust chambers for the purpose of settling dust and condensing fumes that escape from the furnace with the gases. (Hofman, p. 390)

Freyalite. A rare radio-active silicate of thorium, the cerium metals and other elements, found in Norway. (Webster)

Friable. Easy to break, or crumbling naturally (Roy. Com.). Said of certain minerals.

Friction breccia. Angular material derived from earth-movements which crush and break the rock on the two sides of a fault. (Watson, p. 100)

Friedelite. A massive, cleavable to closely compact, hydrated manganese silicate, $H_7(MnCl)Mn_4Si_4O_{16}$. (Dana)

Frijol. 1. (Sp.) A kidney bean. 2. (Mex.) A miner's term for a red conglomerate. (Halse)

Frijolillo (Guanajuato). Round fragments of limestone with calcareous cement. (Dwight)

Fringe. A thin sprinkling of isolated or grouped erratics (bowlders) in front of the extreme terminal moraine of a glacier. (Standard)

Frío (Mex.). 1. Cold. 2. In amalgamation, the condition of "sickened" mercury. (Dwight)

Frios (Bol.). Ores containing but little or no iron. (Halse)

Frisol (Colom.). Any stone, polished by water, and imitating the form of a kidney bean. (Halse)

Frit. 1. The material of which glass is made after having been calcined or partly fused in a furnace before vitrification. 2. To prepare by heat; to fuse partially. (Webster)

Frit brick. A lump of calcined glass materials brought to a pasty condition in a reverberatory furnace preliminary to the perfect vitrification in the melting pot. (Webster)

Fritting. The formation of a slag by heat with but incipient fusion. (Raymond)

Fritting furnace. The reverberatory furnace in which the materials for making glass are fritted. (Standard)

Frog. 1. A device made of rails secured to a plate, or bolted together through distance pieces, forming a connection of one track with another branching from or crossing it. (Webster)

Froment process. A flotation process in which a sulphide ore is agitated in water with a little oil and sulphuric acid, the sulphide particles become oiled and attach themselves to and are floated by gas bubbles. Calcite is added to the ores when needed. Minerals Separation Ltd., bought this patent in 1903. (Liddell)

Front. 1. A designation for the mouth or collar of a bore hole. (Du Pont) 2. *See* Face, 4.

Frontal apron. Same as Apron, 8.

Frontal hammer; Frontal helve (Eng.). A forge-hammer lifted by a cam, acting upon a "tongue" immediately in front of the hammer-head. (Raymond)

Front-and-back shift (Aust.). A system in which one of a pair of miners comes to work two hours before the other, while the latter remains two hours after the first has gone home; the object being to keep the trammers going, who work 10 hours, against the miners' eight hours. (Power)

Front entry. *See* Entry.

Frontón (Mex.). Face of a drift, etc. Any working-face. (Dwight)

Frost pin. A short heavy iron pin used by surveyors to make a hole in frozen ground so that a wooden peg may be driven without breaking. (B. F. Tibby)

Froth. A collection of bubbles resulting from fermentation, effervescence, or agitation (Rickard). A term used in flotation.

Frother. An oil which makes a foam or froth. (Megraw, p. 37)

Froth flotation. A flotation process in which the minerals floated gather in and on the surface of bubbles of air or gas driven into or generated in the liquid in some convenient manner. *See* Film flotation. (O. C. Ralston, U. S. Bur. Mines)

Frozen. 1. Congealed with cold, as the hard surface over cooling molten metal. (Webster)
2. Immovable by reason of expansion consequent upon imperfect lubrication; said of a journal and its bearing. (Standard)
3. Said of vein material which adheres closely to the inclosing walls. (Shamel, p. 150)

Frozen ore. *See* Frozen, 3.

Frozen coal (Ark.). Coal which strongly adheres to the rock above or below it (Steel). *See* Frozen, 3.

Fruchtschiefer. A German name for a variety of spotted, contact schists in the outer zone of the aureole. (Kemp)

Frue vanner. An ore-dressing apparatus consisting essentially of a rubber belt traveling up a slight inclination. The material to be treated is washed by a constant flow of water while the entire belt

is meanwhile shaken from side to side. Other vanners of the side-shake type are the Tulloch, Johnston, and Norbom. (Liddell)

Frush (Scot.). Brittle; having unusually little tenacity; soft and easily broken up. (Barrowman)

Frutos (Sp.). Product, ore, mineral; *Veta en frutos* (Mex.), a vein carrying pay ore. (Halse)

Fuel economizer. A feed-water heater consisting of pipes around which the gases of combustion from a furnace pass. (Standard)

Fuel feeder. A contrivance for supplying a furnace with fuel in graduated quantities (Century). A mechanical stoker.

Fuel gas. Gas used for heating or cooking, as distinguished from illuminating-gas. (Standard)

Fuelle (Mex.). Bellows. *See* **Barquin.** (Dwight)

Fuel ratio. The amount of heating-capacity in a fuel as compared with another fuel taken as a standard. (Century)

Fuente (Sp.). A spring of water. (Halse)

Fuerte (Sp.). Strong; applied to amalgam needing more mercury. Also applied to powerful explosives. (Halse)

Fuga (Sp.). An excess blast in a furnace whereby the charge is cooled. (Halse)

Fulguration. A sudden glistening of molten gold or silver at the close of cupellation (Standard). *See* **Blick.**

Fulgurite. Little tubes of glassy rock that have been fused from all sorts of other rocks by lightning strokes. They are especially frequent in exposed crags on mountain tops. The name is derived from the Latin for thunderbolt. (Kemp)

Fuller. A blacksmith's tool with a round edge, used in grooving or spreading hot iron; a swage or creaser. (Standard)

Fuller's earth. A fine earth resembling clay, but lacking plasticity. It is much the same chemically as clay, but has a decidedly higher percentage of water (Kemp). It is high in magnesia and possesses the property of decolorizing oils and fats by retaining the coloring matter.

Fulminante (Sp.). A blasting cap or detonator. (Halse)

Fulminate. 1. An explosive compound of mercury, $HgC_2N_2O_2$, which is employed for the caps or exploders, by means of which charges of gunpowder, dynamite, etc., are fired. (Raymond)
2. To make a loud sudden noise; to detonate; to explode with a violent report. (Webster)

Fumarole. A hole or spot in a volcanic or other region, from which fumes issue (Webster). The exhalation consists of water-vapor, with such gases as nitrogen, hydrogen, free hydrochloric acid, hydrofluoric acid, and silicon fluoride (Vogt). *See* Solfataras, Mofette, and Soffioni.

Fumarolic. Pertaining to or issuing from a fumarole. (Standard)

Fume. 1. The gas and smoke, more especially the noxious or poisonous gases given off by the explosion or detonation of blasting powder or dynamite. The character of the fume is influenced largely by the completeness of detonation. The degree of confinement of the charge and the size of the detonator has a great influence on the character of the fumes produced. (Du Pont)
2. Consists of metals or metallic compounds that have been volatilized at the high temperatures of the furnaces, condensed at lower temperatures, and carried by furnace gases into the flues. Sulphur trioxide and elemental sulphur, driven off from furnaces and condensed, are also classed as fume. (Bull. 98, U. S. Bur. Mines, p. 63)

In general, all the volatile constituents of the ore charge are represented. The fume frequently contains appreciable amounts of silver, which is decidedly volatile under certain conditions. The particles of fume are very fine and are under the stress of certain physical forces, so they do not settle easily, as most of the flue dust does, but in large proportion pass through the stack with the gases and spread over the surrounding country, unless special preventive methods are used, as is now generally done. (Fulton, Bull. 84, U. S. Bur. Mines, p. 12). *See* Metallurgical fume.

Fuming sulphuric acid. An acid made by dissolving sulphur trioxide in concentrated sulphuric acid. Nordhausen acid. (Webster)

Fundamental complex. *See* Basement complex.

Fundamental rocks. Those rocks forming the foundation, substratum, basis, or support of others. (Roy. Com.)

Fundente (Sp.). In metallurgy, a fusing ore; a flux. (Halse)

Fundición (Mex.). 1. The process of melting silver into bars. 2. *Sistema de F.*, smelting process; *F. en crudo*, smelting direct without roasting. 3. A smelting works, foundry or assay office. 4. Casting. (Halse)

Fundidor (Sp.). Smelter; founder; melter. (Halse)

Fundir (Sp.). To smelt, melt, or cast metals. (Halse)

Fundo minero (Mex.). All the *pertenencias* embraced under one title. (Dwight)

Funnel. The gate or pouring hole of a mold. (Standard)

Funnel box. A square funnel forming one of a series of gradually increasing size, for separating metal-bearing slimes according to fineness (Standard). *See* Spitzkasten.

Fuque (Mex.). The deepest point of excavation. (Dwight)

Fur; Furring (Eng.). A deposit of chemical salts and other material (sediment) upon the inner sides of pumps, boilers, etc. (Gresley)

Furar (Port.). To bore or drill for a blast. (Halse)

Furgen. A round rod used for sounding a bloomery fire. (Raymond)

Furgón (Mex.). Box or closed freight car. (Dwight)

Furlong. One eighth of a mile; that is, 40 rods; 10 chains, or 660 feet. (Webster)

Furnace. 1. A structure in which, with the aid of heat so produced, the operation of roasting, reduction, fusion, steam-generation, desiccation, etc., are carried on, or, as in some mines, the upcast air current is heated, to facilitate its ascent and thus aid ventilation. (Raymond)
2. (Eng.) A large coal fire at or near the bottom of an upcast shaft, for producing a current of air for ventilating a mine. (Gresley)

Furnace bridge. A barrier of fire bricks or an iron-plate chamber filled with water, thrown across the furnace at the extreme end of the fire bars to prevent fuel from being carried into the flues and to quicken the draft by contracting the section of the current of hot gas. (Century)

Furnace cadmium, or cadmia. The zinc-cadmium oxide which accumulates in the chimneys of furnaces smelting zinciferous ores.

Furnace charger. A weighing apparatus for feeding into a furnace mouth the proper proportions of ore, fuel, etc. (Standard)

Furnace holding-the-iron. A condition of the furnace by reason of which it gives much less than normal amount of iron at casting, although the feeding may have been regular. The tap hole runs iron slowly, and amount of cinder is somewhat scanty. *Compare* Furnace losing-the-iron. (Willcox)

Furnace losing-the-iron. Escape of iron from the hearth of a blast furnace into the foundation beneath, indicated by decreased quantity of iron at casting, and appearance of slag at tapping hole. (Willcox)

Furnaceman. One whose sole occupation is to attend a furnace.

Furnace shaft. An upcast shaft used in mine ventilation where a furnace is employed. (C. and M. M. P.)

Furnace stack. A chimney built over a furnace for increasing the draught. (Harr)

Furnisher. A man who furnishes money or machinery to a party of miners, and so becomes entitled to a share of the profits. (Davies)

Furring brick. Hollow brick for lining or furring the inside of a wall. Usually of common brick size, with surface grooved to take plaster. (Ries)

Furrow. *See* Fault trace.

Furtherance (Newc.). An extra price paid to miners when they also haul the coal. (Raymond)

Fuse. 1. A core of black powder wrapped with hemp or cotton threads or tape, with various waterproofing compounds between each, or on the outside, to provide a uniform burning speed of the powder core for the firing of explosives, either with or without a blasting cap. (Du Pont)
2. Any of various devices, as a tube, casing, cord, or the like filled or impregnated with combustible mat-

ter, or a kind of detonator, by means of which an explosive charge is ignited. 3. To liquefy by heat; to render fluid. 4. To unite or blend as if melted together. (Webster) 5. A safety piece in an electric circuit, that fuses when the current is too strong, called often Safety strip or Safety plug (Standard). *See* Fuse plug, 2.

Fuse auger. An instrument for removing part of the filling of a fuse, to regulate its time of burning, the depth of the bore being indicated by a scale. (Webster)

Fuse gage. An instrument for cutting time fuses to length. (Standard)

Fuse lighter. A device for facilitating the ignition of the powder core of a fuse. One form is in the shape of a carpet tack covered with a powder composition; another form is in the shape of a cord, which when ignited burns and maintains a "coal of fire" in contact with the exposed powder in the fuse. (Du Pont)

Fuse lock. A friction lock by which a miner may fire the free end of a blasting fuse by a lanyard. (Standard)

Fuse plug. 1. A plug fitted to the fuse hole of a shell to hold the fuse. 2. A fusible plug that screws into a receptacle, used as a fuse in electrical wiring. (Webster) 3. A plug of fusible metal inserted in a steam boiler so as to prevent any danger that might arise from overheating due to low water. (Standard)

Fusibility scale. A list of minerals arranged in the order of their fusibility, as follows: 1. Stibnite; 2. Natrolite; 3. Almandite garnet; 4. Actinolite; 5. Orthoclase; 6. Bronzite. (Dana)

Fusible. Capable of being melted or liquefied. (Webster)

Fusible metal. Any alloy, usually one containing bismuth, which melts at a comparatively low temperature. (Standard)

Fusible quartz (Eng.). A term occasionally applied by the older mineralogists to obsidian. (Page)

Fusion. 1. Act or operation of melting or rendering liquid by heat. 2. State of being melted or dissolved by heat. 3. Union or blending of things as if melted together. (Webster)

Fuze. Pronounced as though spelled "fuzee." Originally the device used for exploding the charge in a projectile and later used as a designation for an electric blasting cap. Now known as an electric blasting cap (Du Pont). A variation of Fuse.

Fuzze (Eng.). Straws, reeds, or hollow vegetal substances filled with powder (Bainbridge). *See also* Fuse, 1 and 2.

G.

Gab. A hook; specifically, in steam engines, the hook on an eccentric-rod, catching on the rock-shaft pin, in a valve motion. (Standard)

Gabarro (Mex.). Ore in large pieces, from egg size up. (Dwight)

Gabbie (Scot.). A hook on the end of a chain or rope; a coupling. (Barrowman)

Gabbro. A finely to coarsely crystalline igneous rock composed mainly of lime-soda feldspar (labradorite or anorthite), pyroxene, and frequently olivine. Magnetite or ilmenite, or both, and apatite are accessory minerals. It is generally dark colored. Gabbros composed largely or wholly of feldspar are called anorthosites, and those containing orthorhombic pyroxene are often called norites. (U. S. Geol. Surv.) A full review of the meaning and history of gabbro, by W. S. Bayley, will be found in *Jour. of Geology*, August, 1893. p. 435.

Gabronite. A bluish-gray variety of altered wernerite. (Standard)

Gabian. A variety of petroleum obtained at Gabian, department of Herault, France. (Standard)

Gabion. A bottomless wicker cylinder or basket, from 20 to 70 inches in diameter and from 33 to 72 inches high; used in engineering, when filled with stones, to form the foundation of a jetty. (Standard)

Gablack (Derb.). *See* Gavelock.

Gable-rake tile. The full-flanged tile used at the verge of open gables. (Ries)

Gab-lever. A device for disengaging the gab, on the eccentric rod of a steam engine, from the rockshaft. (Standard)

Gad. 1. A steel wedge. 2. A small iron punch with a wooden handle used to break up ore. (Raymond) 3. A metal spike. 4. A chisel or

pointed or wedge-shaped bar of iron or steel about 6 inches long for breaking or loosening ore. 5. A bar, billet or ingot of metal. 6. To break or loosen with a gad, as rock. (Webster)
7. A percussion drill; a jumper. (Standard)

Gadder. A device for supporting a machine drill and permitting a number of parallel holes being driven from one mounting. Distinctly a quarry device. (Gillette, p. 97.) Called also Gadding car, Gadding machine. (Standard)

Gadding machine. *See* Gadder.

Gadolinite. A mineral whose formula is $Be_2Fe(YO)_2(SiO_4)_2$. Crystals often prismatic, rough and coarse; fracture conchoidal or splintery. Brittle. Luster vitreous to greasy. Color black, greenish black, also brown (Dana). A complex silicate of glucinum, iron, and the yttrium and cerium rare-earth metals. Occurs in pegmatites. (U. S. Geol. Surv.)

Gadolinium. A metallic element of the rare earth group. Symbol Gd; atomic weight, 157.3. (Webster)

Gad steel. Flemish steel; so called because wrought in gads or wedges. (Standard)

Gae (Scot.). A fault, slip, or dike. *See also* Gaw, 1. (Barrowman)

Gaffer (Scot.). A foreman. (Barrowman)

Gag. 1. (Eng.). An obstruction in the valve of a pump which prevents it from working. (G. C. Greenwell)
2. A fuller or set hammer, used to straighten railways rails. (Webster)
3. (Derb.). Any piece of timber used temporarily to reinforce other timber until proper timbering can be done. (Hooson)
4. (Eng.). Chips of wood in a shaft bottom, or sump. (Gresley)

Gage; Gauge. An instrument for measuring, indicating, or regulating the capacity, quantity, dimensions, power, amount, proportions, etc., of anything; hence, a standard of comparison. (Standard)

Gage cock. A small cock in a boiler at the water line, to determine the water level. (Nat. Tube Co.)

Gage door. A wooden door fixed in an airway for regulating the supply of ventilation necessary for a certain district or number of men. Also called Regulator. (Steel)

Gage glass. A strong vertical or nearly vertical glass tube connected at its ends with the inside of a steam boiler, showing the water level. (Standard)

Gage-pressure. The pressure shown by an ordinary steam-gage. It is the absoltue pressure less that of the atmosphere. (Ihlseng)

Gage ring (Scot.). A standard ring for measuring buckets of coal or ore. (Barrowman)

Gagger. A piece of iron used in a mold to keep the sand or core in place. (Webster)

Gaging (So. Staff.). A small embankment of slack or rubbish, at the entrance to a heading, to fence it off. (Gresley)

Gahnite. A zinc-bearing spinel, $ZnAl_2O_4$. (Dana)

Gailletins (Belg.). Round coal. (Gresley)

Gain. 1. (Mid.) A transverse channel or cutting made in the sides of a roadway underground for the insertion of a dam or permanent stopping. (Gresley)
2. A notch, mortise, or groove in a timber to receive and support the end of a girder. 3. A cross cut in coal mining. (Webster)

Gain gear (Scot.). The movable machinery of a mill; going gear. (Standard)

Gaiola (Port.). A hoisting cage. (Halse)

Gaist (Scot.). *See* Ghaist; Ghost-coal.

Gait. 1. (Eng.) A journey or trip. (Bainbridge)
2. Two buckets of water carried by a yoke on the shoulders. (Webster)

Gaite (Eng.). Variation of Gate, a road. (Webster)

Gal. (Corn). A hard rusty gossan. (Power)

Galaclite. A variety of white natrolite occurring in Scotland in colorless acicular crystals. (Century)

Gale. 1. (Forest of Dean) A specified tract of mineral property granted by the Crown to a colliery proprietor or company for working the mines. (Gresley)
2. The Royalty paid by a free miner for a plot of land with the right to dig for coal, iron, or stone. 3. The license for the plot of land. (Webster).

Galeage (Eng.). Royalty from mineral land. (Bainbridge)

Galee. A coal miner having (or owning) a gale in the forest of Dean, England. (Standard)

Galemador. 1. (Mex.) A silver-smelting furnace. 2. (Peru) A small furnace for roasting silver ores. (Dwight)

Galemar (Mex.). To reduce ore in a Mexican furnace. (Dwight)

Galeme (Mex.). 1. A cupelling furnace with an absorbent hearth. 2. A reverberatory furnace. (Halse)

Galena; Galenite. Lead sulphide, PbS. Contains 86.6 per cent lead (U. S. Geol. Surv.). The commonest lead mineral. When freshly broken it has a bright silvery appearance, from which it has been called lead-glance.

Galena limestone. A Silurian formation in Illinois and adjoining states. Named from Galena, Illinois. (Webster)

Galenite. *See* Galena, for which it is a synonym.

Galera (Mex.). 1. A long shed on each side of the *patio*. 2. A storeroom for ordinary ore. 3. A grinding mill, or mill house. 4. An irregular ore deposit. 5. A furnace for distilling sulphur. 6. A row of reverberatory furnaces. (Halse)

Galería. 1. (Sp.) A gallery, level. 2. At Bilboa, Spain, a variety of hematite. (Halse)

Galerón (Sp.). A large irregular ore deposit. (Halse)

Galiage. Royalty (Raymond). A variation of Galeage.

Gallatin. The heavy oil of coal tar used in the Bethell process for the preservation of timber. Called also Dead oil. (Standard)

Gallein. A coal tar color (purple and violet) used in dyeing. (Century)

Gallery. In mining, a level or drift. (Raymond)

Gallery-furnace. A retort-furnace used in the distillation of mercury. (Raymond)

Gallery of efflux (Eng.). A drainage tunnel or adit. (Ure)

Gallery work. Pottery, especially of a coarse kind. (Standard)

Galliard (Eng.). A hard flinty rock used for road metal. Called also Calliard. (Standard)

Gallium. A rare metallic element, found combined in certain zinc ores. It is white, hard, and malleable, resembling aluminum and remarkable for its low melting point, 86° F., 30° C. Symbol, Ga; atomic weight, 69.9. (Webster)

Gall of glass. A neutral salt skimmed off the surface of melted crown glass. Also called Sandiver. (Ure)

Gallon. The standard gallon of the United States contains 231 cubic inches, or 8.3389 pounds avoirdupois of distilled water at its maximum density and with a barometer of 30 inches. The English imperial gallon contains almost exactly 1.2 U. S. gallons. (Webster)

Gallows (No. of Eng.). A frame consisting of two uprights and a cross-piece for supporting a mine roof. (Standard)

Gallows frame (Eng.). The frame supporting a pulley, over which the hoisting rope passes to the engine (Ihlseng). *See also* Head frame.

Galt; Gault; Golt (Eng.). *See* Folkstone marl.

Galvanism. Current electricity, especially that arising from chemical action, as distinguished from that generated by heat or induction: a term no longer in scientific use. (Standard)

Galvanize. To coat with zinc. (Raymond)

Galvanized rope. Rope made of wires that have been galvanized or coated with zinc to protect them from corrosion. (C. M. P.)

Galvanized sheets. Iron coated with zinc; the name is derived from the process used in their manufacture, being formerly an electric method. (Skinner)

Galvanizing. The process by which the surface of iron and steel is covered with a layer of zinc. (Nat. Tube Co.)

Galvanometer. An instrument for determining the presence of an electric current, measuring its intensity and direction. (Webster)

Galvanoscope. An instrument for detecting an electric current and showing its direction, differing from a galvanometer in being only qualitative. (Standard)

Galvano-thermometer. An instrument for measuring the heat generated by an electric current, or for measuring the current by the heat it generates. (Standard)

Gambusino (Sp.). 1. A prospector, or searcher of gold. A synonym for Cateador. 2. A tributer. (Halse)

Gamella (Braz.). A wooden bowl, about two feet wide at the mouth, and five or six inches deep, used for washing gold out of the auriferous material collected in sluices and in river sand. (Lock)

Gamma rays. Very penetrating rays not appreciably detected by a magnetic or electric field, emitted by radium and other radioactive substances. (Webster)

Gancho (Mex.). Hook of any kind. Dog used for extracting tapping bars from furnace. (Dwight)

Gang. 1. (Mid.) To go; to move along. 2. A train or set of mine cars or trams. (Gresley)
3. A mine. 4. A set of miners. (Raymond)
5. Gangue. (Standard)

Ganga (Sp.). Gangue or matrix. (Halse)

Gang-art (Eng.). The side of a mine. (Bainbridge)

Gang car. A car which may be loaded with a block of stone and placed beneath the blades of a gang saw. It is a modern substitute for the stationary saw bed. (Bowles)

Gang drill. A set of drills in the same machine operated together. (Standard)

Ganger. 1. (Mid.) One who is employed at conveying minerals along the gangways in or about a mine, which employment is known as ganging. (Gresley)
2. A foreman over a gang of workmen. (Webster)

Ganggesteine. German for dike rocks. (Kemp)

Gang-rider (Eng.). A lad who rides with or upon the trams of an underground engine plane, to give signals when necessary, and to operate any levers, clevises, couplings, etc. (Gresley). A Trip rider.

Gangsman. *See* Ganger.

Gasman. *See* Fireman; *also* Fire boss.

Gangue. The non-metalliferous or non-valuable metalliferous minerals in the ore; veinstone or lode-filling (Rickard). The mineral associated with the ore in a vein. (Raymond)

Gangway. 1. The main haulage road or level (Gresley). Frequently called Entry.
2. (Newc.) A wooden bridge. (Raymond)
3. A passageway or avenue into or out of any enclosed place, as in a mine. (Sangamon Coal Min. Co. v. Wiggerhaus, 122, Illinois, p. 283)

Ganil (Eng.). A sort of brittle limestone. (Standard)

Ganister. 1. A highly refractory siliceous sedimentary rock used for furnace linings. (U. S. Geol. Surv.)
2. A mixture of ground quartz and fire clay, used in lining Bessemer converters (Raymond)
3. A local name for a fine close-grained siliceous clay that occurs under certain coal beds in Derbyshire, Yorkshire, and North of England. (Power)

Ganister beds. Coal-bearing beds of the lower coal measures of England (Standard). *Compare* Ganister, 3.

Gank (Derb.), A red or yellow vein filling extending through joints or fissures. Considered as a sign of ore nearby. (Hooson)

Gannen (No. of Eng.). A road (heading) down which coal is conveyed in cars running upon rails (Gresley). An inclined gangway in a coal mine. (Standard)

Gantry; Gauntry; Gauntree. 1. A frame erected on a gold dredge for supporting different parts of the machinery. (Weatherbe)
2. A bridge or platform carrying a traveling crane or winch and supported by a pair of towers, trestles, or side frames running on parallel tracks. 3. A structure supporting a number of railroad signals for several tracks. (Webster)

Garabato (Mex.). 1. Curved iron bar used in copper-smelting. (Dwight)
2. The suspension hook of a mine lamp. (Halse)

Gard (Eng.). Gravelly sand; a variation of Garde.

Garde (Corn.). Tailings, composed of clay and sand, from tin dressing works. (Hunt)

Gardner crusher. A swing-hammer crusher, the hammers being flat U-shaped pieces hung from trunnions between two disks keyed to a shaft. When revolved, centrifugal force throws the hammers out against the feed and a heavy anvil inside the crusher housing. (Liddell)

Garganite. A name suggested by Viola and de Stefani for a dike rock in the Italian province of Foggia, which in the middle, with prevailing alkali-feldspar, contains both augite and emphibole, *i. e.*, is a vogesite; on the edges it contains biotite, hornblende, olivine, and resembles kersantite. (Kemp)

Garimpeiro (Brazil). A gold-seeker; also a smuggler. (Lock)

Garkupfer (Ger.). Refined copper. (Whitney)

Garland. 1. (So. Staff.) A trough or *gutter* round the inside of a shaft to catch the water running down the sides. (Raymond)
2. (Eng.). A wooden, rectangular frame, strengthened with iron corner-plates, for keeping the coal upon the top of a car. (Gresley)

Garnet. A group of silicate minerals including several species with related chemical structure commonly crystallized in dodecahedrons or trapezohedrons of the isometric (cubic) system. Garnets are not always pure but may contain the molecules of two species giving rise to intermediate types, as the gem rhodolite. Common varieties are: *Almandite*, iron-aluminum garnet (abrasive and gem; precious garnet). *Andradite*, lime-iron garnet. *Essonite*, gem variety of grossularite. *Grossularite*, lime-aluminum garnet. *Pyrope*, magnesia-aluminum garnet; gems—Arizona ruby, Cape ruby, etc. *Rhodolite*, isomorphous mixture of two molecules of pyrope and one molecule of almandite. *Spessartite*, manganese-aluminum garnet; used as a gem, sometimes called Hyacinth (U. S. Geol. Surv.). A vitreous to resinous, transparent to subtranslucent, red brown, yellow, white, apple green, or black, brittle, non-cleavable silicate, crystallizing in the isometric system. (Standard)

Garnet blende. A synonym for Sphalerite, commonly called blende. (Chester)

Garnet rock. A rock composed essentially of garnets. (Kemp)

Garnierite. A hydrous nickel-magnesium silicate; a variety of genthite, $H_2(Ni,Mg)SiO+Aq$. (U. S. Geol. Surv.)

Garrapata (Mex.). A clamp for stretching wires. (Dwight)

Garrote (Mex.). A hoisting brake. *See* Freno. (Halse)

Garrotero (Mex.). Railway brakeman. (Dwight)

Gas. 1. An aëriform fluid, having neither independent shape nor volume, but tending to expand indefinitely. (Webster)
2. In mining, a mixture of atmospheric air with fire damp (Standard). The common name for methane. *See* Fire damp.
3. Gas is considered as a mineral, and while *in situ* is a part of the land. (Westmoreland etc. Gas Co. *v.* De Witt, 130 Pennsylvania State, p. 235)

Gas alarm. An alarm for noting the presence of fire damp or choke damp in a mine. (Standard)

Gas black. A superior kind of lamp black, collected by introducing a cold iron surface into the luminous gas flame. (Webster)

Gas carbon. A compact variety of carbon obtained as an incrustation on the interior of gas retorts, and used for the manufacture of carbon rods or pencils for the electric arc, and for the plates of voltaic batteries. (Webster)

Gas coal. Any coal that yields a large quantity of illuminating gas on distillation (Gresley). It should be free from sulphur and other impurities.

Gas coke. The coke formed in gas retorts, as distinguished from that made in coke ovens. (Webster)

Gas conductor. A pipe for leading combustion gases from the mouth of a blast furnace to a hot-blast stove. (Standard)

Gas detector. A device to show the presence of fire damp, etc., in a mine (Standard). *See also* Safety lamp; Burrell gas detector, Methanometer, and Eudiometer.

Gas drain (Eng.). A heading driven in a mine for the special purpose of carrying off fire damp from any working. (Gresley)

Gas engine. A kind of internal-combustion engine using fixed gas; also, broadly any internal-combustion engine. (Webster)

Gaseous. 1. In the form, or of the nature, of gas; pertaining to gases. 2. Lacking substance or solidity. (Webster)

Gaseous place. A place that is likely to be dangerous from the presence of inflammable gas. (Clark)

Gas field. A tract or district yielding natural gas. (Webster)

Gas firing. The combustion of coal effected by burning in such a way as to produce a combustible gas, which is then burned secondarily in the laboratory of the furnace. (Ingalls, p. 268)

Gas furnace. A furnace using gas for fuel, or one for making gas. (Webster)

Gas gage. An instrument for ascertaining the pressure of gas, generally consisting of a bent graduated tube containing water or mercury, open at one end with the other end screwed into the vessel containing the gas. (Century)

Gas generator. 1. An apparatus for generating gas, as a retort in which hydrocarbons are evolved by heat. 2. A carburetor. 3. A machine for the production of carbonic acid gas, for aërating water. (Webster)

Gash. 1. (Scot.) A break or opening in the strata, usually filled with sand, gravel, or other loose rocks. (Barrowman)
2. Applied to a vein wide above, narrow below, and terminating in depth within the formation it traverses (Raymond). *See also* Gash vein.

Gas-house coal tar. Coal tar produced in gas-house retorts in the manufacture of illuminating gas from bituminous coal. (Bacon)

Gas-house tankage. Material that has been used to remove sulphur compounds from illuminating gas. It contains substances which are poisonous to plants and must be used with great care. It is often rich in nitrogen, containing 5 to 10 per cent. (Amer. Fert. Hand Book, 1917, p. 44)

Gash vein. A mineralized fissure that extends only a short distance vertically. It may be confined to a single stratum of rock, but is a comparatively shallow vein (Ihlseng). *See also* Gash, 2.

Gasket. A thin sheet of composition or metal used in making a joint water, gas, or steam tight. (Nat. Tube Co.)

Gas, natural. *See* Natural gas.

Gasoscope. An apparatus for detecting the presence of dangerous gas escaping into a coal mine or a dwelling house. (Webster)

Gas oil. One of the first products of distillation in the manufacture of lubricating oils. (Mitzakis)

Gasol. A product condensed from casing-head gas by applying a pressure of 850–900 pounds per square inch at ordinary temperature. It has a specific gravity of 0.5, and one pound of the liquid produces seven cubic feet of gas. (Bacon)

Gasoline. A name applied broadly to the lighter products derived from the distillation of crude petroleum having a specific gravity of 0.629 to 0.6673 (95° to 80° B.). It is volatile, inflammable, and used as a fuel in vapor stoves and engines; also as a solvent for fats and oils.

Gas pipe (Mid.). A short wooden pipe about four inches by four inches inside, having its upper end open to the roof, and the lower end opening into the bratticing so that any gas given off in the roof may be carried away as formed (Gresley). Any pipe for conveying gas.

Gas pore. A gas bubble in a mineral. (Standard)

Gas producer. A furnace in which coal is burned for the manufacture of producer gas. There are two types, namely: 1. The step-grate, natural-draught generator, which is but a development of the ordinary fire box. 2. The shaft furnace, with or without a grate and worked by a natural draft or forced draft. The latter type is identical in many respects with a blast-smelting furnace.

The principal producers are: Boetius, Dawson, Dowson, Duff, Hegeler, Mond, Siemens, Smythe, Swindell, Talbott, Taylor, Wellman, and Wilson. (Ingalls, p. 298)

Gas sand. A sandstone containing natural gas. (Webster)

Gassed. *See* Gassing, 2.

Gas separator. *See* Gas trap.

Gasser. A well that yields gas, especially an oil well producing much gas. (Webster)

Gassing. 1. Act or process of subjecting to the action of gas, as lime to chlorine gas in making bleaching powder. 2. The poisoning of persons exposed to noxious fumes or gases. 3. The bubbling of the acid in a storage battery. (Webster)

Gas spectrum. 1. The spectrum, consisting of bright lines or bands, obtained by dispersing the light from a glowing gas or vapor. 2. An absorption spectrum obtained by passing light through a gas or vapor. (Webster)

Gas spurts. Little heaps observed on the surface of certain geological strata containing organic matter; so called because believed to be due to the escape of gas. (Webster)

Gassy. Characteristic of or impregnated with gas, especially coal gas (Standard). Applied to any mine which generates methane, or any other gas.

Gas tank. *See* Gas trap.

Gas tar. Coal tar obtained as a by-product in the manufacture of illuminating gas. (Webster)

Gas trap. One of many devices for separating and saving the gas from the flow and lead lines of producing oil wells. The mixture of oil and gas is allowed to flow through a chamber large enough to reduce the velocity of the mixture to the point at which the oil and gas tend to separate. The gas seeking the top of the chamber, is drawn off free of oil, while the oil is discharged at the bottom. (Tech. Paper No. 209, Bu. Mines) Also called Gas separator; Gas tank.

Gas-water. Water through which coal gas has been passed, and which has absorbed the impurities of the gas. (Century)

Gas well. 1. A deep boring, from which natural gas is discharged. (Raymond)
2. As used in oil and gas leases, a well having such a pressure and volume of gas, and, taking into account its proximity to market, as can be utilized commercially. (Prichard *v.* Freeland Oil Co., 84 S. E. Rept., p. 946)

Gas works. A manufactory of gas, with all of its machinery and appurtenances; a gas plant. (Webster)

Gas zone. A formation which contains capillary or supercapillary voids, or both, that are full of natural gas under pressure considerably exceeding the atmospheric pressure. (Meinzer)

Gatch. Plaster as used in Persian architecture. (Webster)

Gatchers (Corn.). The final sludge or leavings from a tin-ore concentration plant. (Davies)

Gate. 1. (Eng.) Gateway, or gate road. A road or way underground for air, water, or general passage; a gangway. 2. The aperture in a founder's mold, through which the molten iron enters. (Raymond)
3. The closing piece in a stop valve.
4. A valve controlling the admission of water to a water wheel or to a conduit. (Standard)

Gate end. The inby end of a gate. *See* Gate, 1. (Gresley)

Gate-end plate (Mid.). A large sheet-iron plate about four feet six inches square and one-half inch thick, upon which trams (mine cars) are turned round upon coming from the working face to be taken along the gate or roadway (Gresley). A kind of turntable; a turn sheet.

Gate road (Eng.). A road connecting a stall with a main road (Standard). *See* Gate, 1.

Gates canvas table. A large form of inclined canvas table in which the pulp is first classified, then distributed along the upper edge of the table. The concentrates are caught in the warp of the canvas and after this is full, treatment must be stopped while the concentrates are swept or sluiced off. (Liddell)

Gate shutter. A paddle-like implement used to shut off the flow of metal from a mold, and to divert it to other molds. (Standard)

Gate valve. A valve with a sliding gate; stop valve (Standard). *See also* Gate, 3.

Gateway (Mid.). *See* Gate, 1.

Gather. 1. (Derb.) To drive a heading through disturbed or faulty ground in such a way as to meet the seam of coal, at a convenient level or point on the opposite side. *See also* Eat out. (Gresley)
2. To collect (molten glass) from a pot on the end of an iron tube. 3. To collect the loaded mine cars from the rooms or chambers in a train or trip on a main haulage road. (Standard)

Gathering coal (Scot.). *See* Gathering peat.

Gathering iron. The iron used in taking viscid glass from the melting pot. (Standard)

Gathering motor. A light weight type of electric locomotive used to haul loaded cars from the working places to the main haulage road, and to replace them with empties.

Gathering mule. The mule used to collect the loaded cars from the separate working places, and to return empties. (Steel)

Gathering peat (Scot.). A peat used to maintain a fire all night, hot embers being gathered about it. (Standard)

Gathering rod. *See* Gathering iron.

Gathering zone. A term suggested by J. W. Finch for the space above the ground-water level. *See also* Zone of discharge and Static zone. (Lindgren, p. 31)

Gato (Mex.). Jackscrew; railbender. (Dwight)

Gatton (Scot.). *See* Gauton.

Gauge. *See* Gage.

Gauge-door. *See* Gage-door.

Gault. 1. (Eng.). *See* Folkstone marl. 2. To cover with clay obtained from the subsoil. (Webster)

Gauntlet. A narrowing of two single railway tracks almost into the space of one, as on a bridge or in a tunnel, without breaking the continuity of either track by a switch, the two tracks overlapping each other. (Standard)

Gauntree; Ganntry. *See* Gantry.

Gauteite. A name derived from the Gaute Valley, central Bohemia, and given by J. E. Hibsch to a leucocratic dike rock of porphyritic texture and trachytic habit. The phenocrysts are hornblende, augite, and abundant lime-soda feldspar. The groundmass is about 80 per cent feldspar rods, with the remainder, magnetite grains, small hornblendes, augites, biotites, and a little colorless glass. The gauteite is regarded as a complementary dike-rock to neighboring camptonites and is believed to correspond to the deep-seated monzonites. (Kemp)

Gauton (Scot.). A water course cut in the floor of a mine or working. (Barrowman)

Gauze lamp (Scot.). A (so-called) safety lamp, formerly used in the Scotch coal mines. It is a kind of Davy lamp, with a gauze top about three inches in diameter, and has no brass frame to strengthen it and no glass. (Gresley)

Gavel. A mason's setting-maul. (Standard)

Gavelock (Eng.). An iron poker or lever; a crowbar (Bainbridge). Also spelled Gablack.

Gavelor; Gaveler (Derb.). An officer who gives the miner possession of the mine, and who also collects the taxes. (Mander)

Gavia (Spain). A primitive method of carrying ore in baskets on men's shoulders up inclined shafts in which steps were cut. (Halse)

Gaw. 1. (Scot.) A narrow vein of igneous rock intersecting the strata. (Barrowman)
2. A drain or trench. (Webster)

Gawl (Lanc.). An unevenness in a coal wall. (Gresley)

Gayeterie (Belg.). Second quality coal remaining after the large pieces have been removed. *See* Gayette.

Gayette (Belg.). Large picked coal. A variation of French *Gaillette.*

Gayley process. The process of removing moisture from the blast of a blast-furnace by reducing the temperature so that the moisture will be deposited as snow or ice. The use of the dehydrated blast effects great fuel economy, and promotes regularity in iron-smelting operations. (Webster)

Gay-Lussac's tower. In sulphuric-acid making, a tower filled with pieces of coke over which concentrated sulphuric acid trickles down and, meeting the gas issuing from the lead chambers, absorbs its nitrous anhydride, which otherwise would be lost (Standard). *Compare* Glover's tower.

Gaylussite. A hydrous carbonate of sodium and calcium mineral, $CaCo_3.Na_2Co_3.5H_2O$. (Dana)

Gazogene. *See* Gasogen.

Geanticline. A great upward flexure of the earth's crust; opposed to Geosyncline. (Webster)

Gears; Pair of gears. 1. Two props and a plank, the plank being supported by the props at either end. 2. The teeth of a gear wheel or pinion. (C. and M. M. P.) 3. (No. of Eng.) *See* Double timber. Also staging and rails erected at quays over coal chutes. (Gresley)

Geat. The hole in a mold through which the metal is poured in casting. *See* Gate, 2. (Standard)

Gedanite. A resin resembling amber, but not containing succinic acid and less rich in oxygen; it is found on the shores of the Baltic. *See also* Succinite. (Bacon)

Gee. 1. To cause (a draft animal) to turn to the right. 2. To turn to the right, away from the driver: opposed to Haw; in the imperative, addressed to oxen, mules, or horses as a command. (Standard)

Geest. 1. A name proposed by J. A. DeLuc in 1816 for "the immediate products of rock decay *in situ*." It is a provincial word for earth in Holland and northern Germany. *Compare* Laterite, Saprolite. (Kemp) 2. High, gravelly land; gravel or drift. (Standard)

Gefärht (Ger.). The course or direction of a lode. (Davies)

Geg; Gag (Scot.). A piece of stone or other obstruction preventing the proper closing of a pump valve. The valve is said to be gegged when so obstructed. (Barrowman)

Geisothermal. Same as Isogeothermal (Standard). *See* Isogeothermal lines.

Geissler's tube. A sealed glass tube containing some highly rarified gas and having electrodes at either end which can be connected with an induction coil. When an electric discharge is passed through it the gas becomes luminous. (Standard)

Gel. A form of matter in a colloidal state that does not dissolve but nevertheless remains suspended in a solvent from which it fails to precipitate without the intervention of heat or of an electrolyte. (Rickard)

Gelatin dynamite. An explosive, the composition of which varies between wide limits, depending upon its use. A typical composition is: 62.5 per cent nitroglycerin; 2.5 collodion cotton; 25.5 sodium nitrate; 8.7 meal, and 0.8 soda (Brunswig, p. 300). It is a plastic, water-proof high explosive, of high density, used principally for close work and where it is exposed to water. (Du Pont)

Gelatinization. Solubility with the formation of jelly-like silica. (A. F. Rogers)

Gelation. Solidification, especially by cooling. (Standard)

Gelignite. The term by which gelatin dynamite is known abroad. (Du Pont)

Gem. 1. A general term for any precious or semi-precious stone, as diamond, ruby, topaz, etc., especially when cut or polished for ornamental purposes. 2. Archæologically, the term is restricted to engraved stone, *e. g.*, intaglios and cameos. 3. In the mineralogical sense, one of the orders of minerals used by Mohs, distinguished by their hardness—enough to scratch quartz—transparency, nonmetallic luster, but generally brilliant and beautiful. (Power)

Gemmary. 1. The science of gems. 2. A house or receptacle for gems or jewels; also gems collectively. 3. An engraver of gems. (Standard)

Gem stone. A precious stone; a mineral suitable for cutting as a gem. (Standard)

Generating station. A station in which electric generators are operated by prime movers. (Clark)

Generation. In petrology, all those crystals, of one or several species, that form at the same period of the cooling and solidification of an igneous rock (La Forge). The same species may have one, two, or very rarely three generations.

Generator. 1. A source of electricity, especially one that transforms heat or mechanical work directly into electric energy, as opposed to a voltaic battery. *See* Dynamo. 2. A vessel, chamber or machine in which the generation of a gas is effected, as by chemical action. (Standard)

Generator gas. Producer gas. (Webster)

Geneva ruby. An artificial ruby. (Power)

Genthite. A hydrous nickel-magnesium silicate mineral, theoretically $2NiO.2MgO.3SiO_2.6H_2O$, but the nickel content is variable. (U. S. Geol. Surv.)

Geo. 1. (Iceland) A narrow inlet walled in by steep cliffs. 2. An element in many compound words of Greek origin, meaning the earth. (Century)

Geocerain. *See* Geocerite.

Geocerellite. A white, brittle, alcohol-soluble oxygenated hydrocarbon which melts at 82° C. (Bacon)

Geocerite. A wax-like, white oxygenated hydrocarbon which melts at about 80° C. It is soluble in alcohol and is unacted upon by a hot potassium hydroxide. Geocerite occurs in the brown coal of Gesterwitz. *See* Geomyricite. (Bacon)

Geocronic. Of or pertaining to geological time (Standard). Now obsolete.

Geochrony. Geologic chronology; the system of time divisions used in geology (Webster). Now obsolete.

Geocronite. An alchemist's name for lead. A lead gray sulphide mineral of antimony and lead, $5PbS.S6_2S_3$. (Webster)

Geode. 1. A hollow nodule or concretion, the cavity of which is lined with crystals. (U. S. Geol. Surv.) 2. The cavity of such a nodule. (Webster)
3. (Leic.) Large nodules of ironstone, hollow in the center. (Gresley)

Geodesy. The science and art of measuring portions of the earth's surface by triangulation and astronomical observation; the determination of the magnitude and figure of the earth: distinguished from surveying, which is concerned only with limited tracts, as farms or counties. (Standard)

Geodetics. *See* Geodesy.

Geogeny. The study of the genesis or formation of the earth (Standard). An obsolete term.

Geognosy. That part of geology which treats of the materials of the earth and its general interior and exterior constitution; sometimes nearly synonymous with geology. (Webster)

Geography. The science that treats of the surface of the earth, including its form and development, the phenomena that take place thereon, and the plants, animals, and peoples that inhabit it, considered in relation to the earth's surface; also a book or treatise on the above subject. (La Forge)

Geologian. An old term for Geologist.

Geological formations. Groups of rocks of similar character and age. (Lawver)

Geological horizon. Rocks of one geological age. (Weed)

Geologic high. Sometimes used in oil fields to indicate a later geological formation regardless of elevation; opposed to Geologic low, which refers to earlier formations. *Compare* Topographic high.

Geologic low. *See* Geologic high.

Geologist. One versed in geology, or engaged in geological study or investigation. (Standard)

Geology. The science which treats of the history of the earth and its life, especially as recorded in the rocks. Three principal branches or phases are usually distinguished: 1. *Structural*, or *geotectonic* geology, treating of the form, arrangement, and internal structure of the rocks. 2. *Dynamic geology*, dealing with the causes and processes of geological change. 3. *Historical geology*, which, aided by other branches, aims to give a chronological account of the events in the earth's history. (Webster)

Other subdivisions are: *Economic geology*, that branch of geology which deals with the applications of the science in industrial relations and operations. *Legal geology*, the application in litigation of the facts and principles of geology, particularly its subdivisions, mineralogy, economic geology, and mining geology. *Mining geology*, a subdivision of economic geology concerned with the application of geologic facts and principles to mining. *Stratigraphic geology*, a study of the succession of the beds of rock laid down during the progress of geologic ages. (Shamel, p. 11)

Geomorphic. Of, or pertaining to, the figure of the earth or the form of its surface; resembling the earth. (Webster)

Geomorphogeny. That part of geomorphology which treats of the origin and development of the earth's surface features. (La Forge)

Principal divisions of geologic time.

[U. S. Geological Survey.]

Era.	Period.	Epoch.	Characteristic life.	Duration, according to various estimates.
				Millions of years.
Cenozoic (recent life).	Quaternary.	Recent. Pleistocene (Great Ice Age).	"Age of man." Animals and plants of modern types.	1 to 5.
	Tertiary.	Pliocene. Miocene. Oligocene. Eocene.	"Age of mammals." Possible first appearance of man. Rise and development of highest orders of plants.	
Mesozoic (intermediate life).	Cretaceous.	(b)	"Age of reptiles." Rise and culmination of huge land reptiles (dinosaurs), of shellfish with complexly partitioned coiled shells (ammonites), and of great flying reptiles. First appearance (in Jurassic) of birds and mammals; of cycads, an order of palmlike plants (in Triassic); and of angiospermous plants, among which are palms and hardwood trees (in Cretaceous).	4 to 10.
	Jurassic.	(b)		
	Triassic.	(b)		
Paleozoic (old life).	Carboniferous.	Permian.	"Age of amphibians." Dominance of club mosses (lycopods) and plants of horsetail and fern types. Primitive flowering plants and earliest cone-bearing trees. Beginnings of backboned land animals (land vertebrates). Insects. Animals with nautilus-like coiled shells (ammonites) and sharks abundant.	17 to 25.
		Pennsylvanian.		
		Mississippian.		
	Devonian.	(b)	"Age of fishes." Shellfish (mollusks) also abundant. Rise of amphibians and land plants.	
	Silurian.	(b)	Shell-forming sea animals dominant, especially those related to the nautilus (cephalopods). Rise and culmination of the marine animals sometimes known as sea lilies (crinoids) and of giant scorpion-like crustaceans (eurypterids). Rise of fishes and of reef-building corals.	
	Ordovician.	(b)	Shell-forming sea animals, especially cephalopods and mollusk-like brachiopods, abundant. Culmination of the buglike marine crustaceans known as trilobites. First trace of insect life.	
	Cambrian.	(b)	Trilobites and brachiopods most characteristic animals. Seaweeds (algæ) abundant. No trace of land animals found.	
Proterozoic (primordial life).	Algonkian.	(b)	First life that has left distinct record. Crustaceans, brachiopods, and seaweeds.	50+
	Archean.	Crystalline rocks.	No fossils found.	

Geomorphology. 1. That branch of physical geography which deals with the form of the earth, the general configuration of its surface, the distribution of the land, water, etc. 2. The investigation of the history of geolgic changes through the interpretation of topographic forms. (Webster)

Geomyricin. *See* Geomyricite.

Geomyricite. A wax-like, white mineral, melting at about 80° C., and soluble in hot absolute alcohol and ether; its composition ($C_{24}H_{48}O_2$) is near that of certain vegetal waxes. (Bacon)

Geonomy. The science of the physical laws of the earth. It includes geology and physical geography. (Webster)

Geophone. A device to determine beneath the surface the exact location of sounds transmitted through the ground. It is a recent invention and may prove useful in finding men imprisoned by mine disasters.

Geophysical. Relating to the physics of the earth. (Century)

Geordie. 1. (Scot.) A coal worker. 2. A miner's name for a safety lamp invented by George Stephenson. (Webster)

Geordie turn-out (Aust.). A turn-out (switch), from a heading to a bord, made of iron bars of square cross section instead of ordinary T-rails, so that the same turn-outs can be used to the right or left by simply reversing them. (Power)

Geostatic. Capable of sustaining the pressure of superincumbent earth. (Century)

Geosyncline. A great downward flexure of the earth's crust; opposed to Geanticline. (Webster)

Geotectonic. Pertaining to the form, arrangement, and structure of the rock masses composing the earth's crust. Structural. (Webster)

Geothermic; Geothermal. Of, or pertaining to, the heat of the earth's interior. (Webster)

Geothermic degree. The average depth within the earth's crust corresponding to an increase of one degree in temperature. (Webster)

Gerente (Mex.). Business manager. (Dwight)

Gerhardtite. Basic cupric nitrate, $Cu(NO_3)_2 . 3Cu(OH)_2$. In pyramidal orthorhombic crystals. Color, emerald green. From the copper mines at Jerome, Ariz. (Dana)

German. A straw filled with gunpowder to act as a fuse in blasting operations. (Gresley)

German cupellation. The characteristics of this method are: a large reverberatory furnace with a fixed bed and a movable roof, that the bullion to be cupelled is all charged at once and that the silver is not refined in the same furnace where the cupellation is carried on. (Hofman, p. 508)

Germanium. A grayish white rare metallic element, resembling silicon and carbon in some respects, and tin in others. Symbol, Ge; atomic weight, 72.5; specific gravity 5.46. (Webster)

German process. In copper smelting, the process of reduction in a shaft-furnace, after roasting, if necessary (Raymond). *See* German reduction process. Also called Swedish process.

German reduction process. This process consists in: (a) Roasting the ore; (b) Melting and obtaining a matte with 30 to 40 per cent of copper called coarse metal; (c) Roasting the coarse metal; (d) Melting and obtaining a matte with 60 to 70 per cent copper called fine metal; (e) Roasting the fine metal; and (f) Melting and obtaining black copper. (Goesel)

German silver. A white alloy of nickel, copper, and zinc. (Raymond)

German steel. A metal made from charcoal iron obtained from bog iron or from sparry carbonate of iron. (Standard)

Gersdorffite. A mineral, sulpharsenide of nickel, NiAsS or $NiS_2.NiAs_2$. Iron and sometimes cobalt replace more or less of the nickel. Is usually massive and has a silver-white to steel-gray color. (Dana)

Gerstenhofer furnace. A shaft furnace filled with terraces or shelves, through which crushed ore is caused to fall, for roasting. (Raymond)

Get. 1. (Eng.) To work away or excavate by mining either under or above ground. 2. The produce or output, in tons, of a colliery or mine during a certain period. (Gresley)

Get a clean-up (Ark.). To have an opportunity to load out all the coal a miner has loosened. (Steel)

Getter (Eng.). A miner who gets out coal or ore. (Standard)

Getting (Eng.). Cutting, mining, and loading coal, etc., in a mine. (Gresley)

Getting-in-the-top (Eng.). Cutting out and timbering the crown of the excavation for the tunnel. (Simms)

Getting rock (So. Staff.). Clay ironstone in the roof of a coal seam, which is worked in conjunction with the coal. (Gresley)

Geyser. A spring from which hot water and steam, and in some cases mud, are intermittently, periodically, and explosively thrown vertically, like a fountain, to a considerable height. (La Forge)

Geyser basin. An area in which geysers are grouped. (Standard)

Geyserite. A hydrated form of silica, a variety of opal, deposited around some hot springs or geysers. (Dana)

Ghaist (Scot.). The white ash or cinder of shale of shaly coal. (Barrowman)

Ghat; Ghaut (India). Literally, a pass often difficult and narrow, through a mountain ridge, or from the lower plains to the higher plateaux (Oldham). A range or chain of mountains or hills, or the scarped wall of a table-land. (Standard)

Ghost. 1. (So. Staff.) A blue cap on a candle or lamp. (Gresley)
2. (Scot.) *See* Veal.

Ghost-coal (Scot.). A coal which yields a fixed white incandescent light, as of a specter, in a burning fire (Standard). Called also Gaist.

Ghurr; Thurr; or "**The mother of metals.**" A term used by alchemists for the mineral substance which in time is supposed *to ripen*, and become real ore. Glauber the alchemist (from whom we get "Glauber's salts," sulphate of soda) tells us "that in Germany the miners know when the ores are not grown to perfection, and usually say they are come too soon; and shut up the mine again for some years till it is ripened and grown to perfection." (Hunt)

Giallo antico marble. A yellow marble used by the ancient Greeks and Romans; hence the name *Giallo antico* or antique yellow. The source is Algeria. (Merrill)

Giant. A large nozzle used in hydraulic mining. (Webster)

Giant granite. *See* Pegmatite.

Giant kettle. One of the numerous very large potholes (moulins) on the coast of Norway, probably formed by englacial waterfalls. (Standard)

Giant powder. A form of dynamite consisting of a mixture of nitroglycerin and kieselguhr. (Webster)

Giant's Causeway. A sheet of columnar basalt covering large areas where the structure is finely displayed in the close-fitting hexagonal pillars distinctly marked, and varying in diameter from 15 to 20 inches, with a height of 20 feet in some places. It forms a prominent cliff on the north coast of Ireland.

Gib. 1. (Scot.) A sprag; a prop put in the holing of a seam while being under-cut. (Barrowman)
2. A piece of metal often used in the same hole with a wedge-shaped key for holding pieces together. (C. and M. M. P.)

Gib and key (Scot.). A two-part tightening wedge, one part, the gib, being fixed while the other part, the key or cotter, is adjustable lengthwise. (Standard)

Gibber. In geology, a facetted pebble or glyptolith; a dreikanter. (La Forge)

Gibbsite. A monoclinic hydroxide of aluminum mineral, $Al_2O_3 3H_2O$. (Dana)

Gieseckite-porphyry. A nephelite porphyry from Greenland, whose nephelite phenocrysts are altered to the aggregate of muscovite scales, which was called gieseckite under the impression that it was a new mineral. Liebenerite porphyry is the same thing from Predazzo, in the Tyrol. (Kemp)

Gig. 1. (Scot.) A winding engine. (Barrowman)
2. (Eng.) A small sump. *See* Sump, 1. (Bainbridge)
3. (Eng.) A two-storied box or cage for use in a mine shaft; also a kibble. (Webster)

Gig house (Scot.). A winding-engine house. (Barrowman)

Gild. To wash over or overlay thinly with gold; to coat with gold, either in leaf or powder. 2. To overlay with any other substance for the purpose of giving the appearance of gold. (Standard)

Gillie's process. A flotation process based upon the principles of the Potter-Delpeat process but embodying some unique apparatus. The process never had any commercial success. (T. J. Hoover, p. 15)

Gilpin county table. *See* End-bump table.

Gilsonite; Uintaite. 1. A brilliant black, very brittle variety of asphalt having a marked conchoidal fracture and a brown streak. Upon exposure to air readily breaks down into a brown powder. Decrepitates but fuses easily in a candle flame, and is soluble in carbon disulphide (CS_2), alcohol, and turpentine. (U. S. Geol. Surv.)
2. A solid asphaltum found in place, in a vein, lode, or rock. (Webb *v.* American Asphaltum Min. Co., 157 Fed. Rept., p. 205)

Gime (Eng.). A hole washed in an embankment by a rush of water through a leak. (Standard)

Gin. 1. (Eng.) A drum and framework carrying pulleys, by which the ore and waste are raised from a shallow pit (Gresley). A whim. Also called Horse gin. Gin is a contraction of engine.
2. A pump worked by a windlass.
3. A pile-driving machine. (Standard)

Gin beam (So. Staff.). A timber crossbar carrying the pulley wheels over the top of a head frame. (Gresley)

Gin block. A simple form of tackle-block attached to a gin. (Standard)

Ginging (Derb.). The lining of a shaft with masonry. (Raymond)

Gingoni (Derb.). Walling up a shaft, instead of timbering, to keep the loose earth from falling. (Min. Jour.)

Gin horse. A horse working a gin, or mill (Standard). *See* Gin, 1.

Ginney (Nova Scotia). A prop.

Ginny carriage (Eng.). A small strong carriage for materials. (Webster)

Ginny rails (Eng.). Track rails for ginny carriages. (Webster)

Gin pit. A shallow mine, the hoisting from which is done by a gin. (Webster)

Gin pole. Any of the three poles of a hoisting gin. A single pole held in position by guys. (Webster)

Gin race. 1. (Eng.) A wide excavation near the top of an underground inclined plane in which a gin is fixed. (Gresley)
2. The track or path of a horse turning a gin. Also called Gin ring. (Webster)

Gin ring. The circle round which a horse moves in working a gin or horse-whip. (Century)

Gin tackle. A tackle arranged for use with a gin; especially, a combination of a double with a triple pulley block which multiplies by five the power exerted. (Standard)

Gin wheel. The cylinder of a gin or winch. (Standard)

Gipsy winch. A small winch that may be attached to a post, working either by a rotary motion or by the reciprocating action of a handle having a pair of pawls and a ratchet. (Standard)

Giraffe. 1. A cage-like mine car especially adapted for inclines, having the frame higher at one end than at the other. (Standard)
2. A mechanical appliance for receiving and tripping a car of ore, etc., when it arrives at the surface. (Duryee)
3. A multiple-deck skip. (Halse)

Girasol. Opal. Bluish white, translucent, with reddish reflections in a bright light. (Dana)

Girdle. 1. (No. of Eng.) A thin bed of stone exposed in a shaft or bore hole. (Gresley)
2. (Newc.) A thin stratum of coal. (Power)
3. A thin sandstone stratum. 4. The peripheral line of a cut gem, at which it is held by the setting. (Standard)

Girth; Girt. 1. In square-set timbering, a horizontal brace in the direction of the drift. (Raymond)
2. A small girder. (Standard)

Gis (Mex.). Chalk; crayon; pencil. (Dwight)

Gismondite. A mineral, $CaAl_2Si_2O_8 + 4H_2O$. In pyramidal crystals, pseudo-tetragonal. Colorless or white, bluish white, grayish, reddish. (Dana)

Gizzen (Scot.). To shrink from dryness so as to leak; as a pail gizzens; leaky. (Standard)

Gjer's soaking-pit. A cavity lined with refractory material used in metal working to inclose large ingots, in order to preserve them at a high temperature, and thus avoid the necessity of reheating. (Century)

Glacial. In geology, pertaining to, characteristic of, produced or deposited by, or derived from a glacier. (La Forge)

Glacial boundary. The boundary line of the utmost extension of the lower margin of glacier land-ice in any region, often extending beyond the outer terminal moraine. (Standard)

Glacial drift. *See* Drift, 6.

Glacial epoch. The Pleistocene epoch, the earlier of the two epochs comprised in the Quarternary period: characterized by the extensive glaciation of regions now free from ice. (La Forge)

Glacial erosion. The erosion of earth and rocks produced by glacier ice charged with detritus, and assisted by glacial streams (Standard). *See* Glaciation, 1.

Glacialism. The glacier theory. (Standard)

Glacialized. Subjected to the action of ice. (Standard)

Glacial planing and polishing. The leveling and smoothing of rock surfaces by ice erosion. (Standard)

Glacial scoring. The scratching and grooving of a rock surface by glacial erosion. (Century)

Glacial scratches. *See* Glacial striæ.

Glacial striæ. 1. Usually straight, more or less regular scratches, commonly parallel in sets, on smoothed surfaces of rocks, due to glacial-abrasion; glacial scratches. 2. Curved, crooked, and intermittent gouges, of irregular depth and width, and rough definition, on certain rock-surfaces, sometimes due to abrasion by icebergs. (Standard)

Glacial terrace. A glacial deposit rearranged in terrace form. (Standard)

Glaciate. To overspread with glacial ice, or to produce the phenomena of rock planation, rock-scoring, drift, etc. (Standard)

Glaciated. Covered by and subjected to the action of a glacier. (La Forge)

Glaciation. 1. The effect produced upon an area through being covered by a glacier and through the erosion, transportation, and deposition of material by the glacier. (La Forge)
2. The act of or result of freezing, or the state of being frozen. (Standard)

Glacic. Same as glacial. (Standard).

Glacier. A stream or sheet of ice, formed by the compacting and recrystallization of unmelted snow accumulated to a great thickness, flowing down a mountain valley or outward across country in all directions from a center of accumulation (La Forge). When a glacier reaches the sea it often breaks off and forms ice bergs.

Glacier burst. The sudden release of a reservoir of water which has been impounded within or by a glacier. (Century)

Glacière (Fr.). An artificial or natural cavity, in a temperate climate, in which a mass of ice remains unthawed throughout the year; an ice glen; ice cave. (Standard)

Glacier grain. 1. The granular texture of glacier ice. 2. One of the grains of ice in a glacier. (Century)

Glacier meal. *See* Rock flour.

Glacier milk. Water issuing from beneath a glacier and exhibiting a characteristic white color due to suspended triturated rock. (Webster)

Glacier mud, or silt. The pulverulent material, produced by glacial erosion, that is washed out from beneath a glacier and deposited at lower levels by glacial streams. (Standard)

Glacier snow. The compacted mountain snow that is in the intermediate stage between ordinary snow and glacier ice. (Standard)

Glacier table. A block of stone left and supported above the surface of a glacier on a column of ice formed by the melting away of the surrounding glacier ice. (Webster)

Glacier theory. The theory that large elevated portions of the temperate and frigid zones were covered during the early Quaternary, and perhaps during some earlier epochs, by slowly moving ice sheets and glaciers, that tra sported vast masses of drift to lower latitudes, assisted by icebergs drifting along the coast. (Standard) No longer a theory, but accepted as fact.

Glacioaqueous. Pertaining to or resulting from the combined action of ice and water. (Standard)

Glaciofluvial. Of, pertaining to, produced by, or resulting from combined glacier action and river action. (Standard)

Glaciolacustrine. Pertaining to or characterized by glacial and lacustrine conditions. Deposits made in lakes whose borders were affected by glacier ice, or by water flowing directly from glaciers. (Webster)

Glaciology. That branch of geology which treats of glaciers, of the deposits formed by them, and of the results of their action in modifying topography. (La Forge)

Glaciomarine. Of, or relating to processes or deposits which involve the action of glaciers and the sea, or the action of glaciers in the sea. (Century)

Glacure (Fr.). A thin glazing on fine pottery. (Standard)

Glance. A term used to designate various minerals having a splendent luster, as silver glance, lead glance, etc. (Roy. Com.)

Glance coal. A term for Anthracite. (Gresley)

Glance cobalt. Same as Cobaltite. (Standard)

Glance copper. Same as Chalcocite. (Standard)

Glance pitch. A pure quality of asphalt; manjak. (Webster)

Gland. 1. (Scot.) A malleable iron band surrounding a pipe or log and tightened by means of bolts. (Barrowman)
2. The outer portion of a stuffing box, having a tubular projection embracing the rod, extending into the bore of the box, and bearing against the packing. 3. The fixed engaging part of a positive-driven clutch. 4. A bar hooked at both ends for clamping the parts of a molder's flask. (Standard)

Gland bridge (Scot.). A bar or strip of iron to which a gland is sometimes bolted. *See also* Gland, 1. (Barrowman)

Glass. 1. The amorphous result of the quick chill of a fused lava. *See* Obsidian; *also* Volcanic glass. (Kemp)
2. (Eng.) A collier's word for a dial. (Gresley)
3. A compound of silica with at least two metallic oxides, usually those of sodium, potassium, or lead. It is generally transparent or translucent, is brittle and sonorous at ordinary temperatures, and when heated becomes soft and ductile, finally melting. The point of fusion differs with its composition. It breaks with a conchoidal (commonly called vitreous) fracture, and is acted on by hydrofluoric acid, but not by ordinary solvents. (Standard)

Glassen (Local, Eng.). To coat with or as with a glaze. (Standard)

Glass furnace. A furnace for fusing together the materials of which glass is made, or one for remelting glass frit and making it ready for working. (Standard)

Glass gall. A whitish scum cast up from the materials of glass in fusion, and removed by the aid of shovels. (Webster)

Glass inclusion. In crystals of igneous rocks, an inclusion of glass or some lithoid substance. (Standard)

Glass metal. The fused and refined material of which glass is made. (Century)

Glass rock. A pure cryptocrystalline Trenton limestone in northern Illinois and southern Wisconsin. (Ore dep., p. 234)

Glass sand. An extremely pure silica sand useful for making glass and pottery. (Bowles)

Glass seam. A joint plane in a rock that has been re-cemented by deposition of calcite or silica in the crack. (Bowles)

Glass tiff. Calcite. (Power)

Glass wool. A fibrous wool-like material, composed of fine filaments of glass intermingled like mineral wool (Standard). *See* Mineral wool.

Glauberite. A mineral, sodium-calcium sulphate, $Na_2SO_4.CaSO_4$. (U. S. Geol. Surv.)

Glauber salt. *See* Mirabilite.

Glaucodot. Sulpharsenide of cobalt and iron, (Co, Fe)AsS. In orthorhombic crystals. Also massive. Luster metallic. A grayish tin-white mineral. (Dana)

Glaucolite. A variety of wernerite having a blue or green tint. (Standard)

Glauconite; Greensand. Essentially a hydrous silicate of iron and potassium, but the material is usually a mixture and consequently varies much in composition. The potash ranges from 2.2 to 7.9 per cent. *See also* Marl. (U. S. Geol. Surv.)

Glaucophane. One of the monoclinic amphiboles. A silicate of sodium, aluminum, iron, and magnesium. Essentially $NaAl(SiO_3)_2.(FeMg)SiO_3$. (Dana)

Glaucopyrite. A variety of lollingite containing cobalt. (Standard)

Glazed. Containing considerable silica: said of pig iron, which is thus made brittle and difficult to puddle. (Standard)

Glaze kiln. A kiln for firing glazed biscuit ware. (Standard)

Glazier. One who applies glaze to pottery. (Standard)

Glazing barrel. A rotating barrel in which gunpowder is glazed with graphite. (Standard)

Glazy. Vitreous; glassy; dull. Having a glazed appearance as the fractured surface of some kinds of pig iron. (Webster)

Glebe (Gt. Brit.). A tract of land containing mineral (ore). (Standard)

Gleg parting. 1. (Scot.) The easy parting of one stratum from another. (Barrowman)
2. Sharp; smooth or slippery. (Webster)

Glen. A small valley; a secluded hollow among hills. (Standard)

Glesite. A resin occurring, with succinite on the shores of the Baltic; it has a brown color and a specific gravity of 1.015 to 1.027. (Bacon)

Gliding. A change of form by differential movements along definite planes in crystals without fracture. (C. K. Leith, Bull. 239, U. S. Geol. Surv., p. 138)

Gliding planes. Directions parallel to which a slipping of the molecules may take place under the application of mechanical force, as by pressure (Dana). Also called Glide planes.

Glimmer. Mica (Standard). *See* Glist, 1.

Glimmering. As applied to the degree of lustre of minerals, means those which afford an imperfect reflection, and apparently from points over the surface, as flint, chalcedony (Dana). *Compare* Glistening.

Glist. 1. (Corn.) Mica. (Raymond)
2. A gleam; sparkle. (Webster)
3. (Eng.) A dark, shining mineral resembling black tourmaline. (Standard)

Glistening. As applied to the degree of lustre of a mineral means those minerals affording a general reflection from the surface, but no image, as talc, chalcopyrite (Dana). *Compare* Glimmering.

Glister (Va.). To increase the heat of (a brick-kiln) by stirring the fire and supplying fuel. (Standard)

Glit (Scot.). The slime of a river bed. (Standard)

Globe valve. 1. A valve with approximately a spherical chamber. 2. A valve in which a ball is pressed against a seat to close it. (Standard)

Globulite. 1. A very minute droplike body, the simplest kind of a crystallite. (Webster)
2. A tiny, rounded, incipient crystal form visible in some volcanic glasses when they are examined in thin sections under a microscope. (Ransome)

Glockerite. A mineral, $2Fe_2O_3.SO_3.6H_2O$. Massive, sparry, earthy, or stalactitic. Color, brown to ocher-yellow to pitch black; dull green. (Dana)

Glomeroporphyritic. A textural term proposed by Tate for those porphyritic rocks whose feldspar phenocrysts are made up of an aggregate of individuals instead of one large crystal. *Compare* Ocellar. (Kemp)

Gloom. A stove for drying gunpowder; drying oven. (Standard)

Glory hole. 1. A large open pit from which ore is or has been extracted (Weed). *See also* Milling.
2. An opening through which to observe the interior of a furnace. (Standard)

Glory-hole system. A method of mining using a system of haulageways beneath the block of ore, which has had its top surface exposed by the removal of the overburden. Connecting with the haulageways are chutes that extend up to the surface, and are spaced at intervals of 50 ft., or at any other convenient distance. The excavation of the ore begins at the top of the chute, and the broken ore is removed by loading it out from the chutes into cars on the haulage level. The ore block is worked from the top down. The method is similar in principle to underhand stoping (Young). Also called Milling system and Chute system.

Glossary. A collection of notes or explanations of words and passages of a work or author; a partial dictionary of a work, an author, a dialect, art, or science, explaining archaic, technical, or other uncommon words. (Webster) In addition, this glossary contains provincialisms and local terms used by miners, as well as many words originating in other industries but adapted to the mining and mineral industry.

Gloss coal. A variety of brown coal, compact, deep black, with conchoidal fracture well developed, possessing a resinous to glossy and metallic luster. It is the hardest and most compact of the lignites; its specific gravity varies from 1.2 to 1.5. (Bacon)

Glost. In ceramics, lead glaze used in the manufacture of pottery. (Standard)

Glost oven. In ceramics, a glazing-kiln. (Standard)

Glover's tower. In sulphuric-acid works, a tower through which the acid from the Gay-Lussac tower trickles and yields nitrous anhydride to the gases entering the lead-chambers, at the same time cooling them. (Standard)

Glow. The incandescence of a heated substance, or the light from such a substance; white or red heat; as, the *glow* of melted iron; the *glow* of embers. (Standard)

Glucinum. An element occurring only in combination in a few comparatively rare minerals, as beryl, chrysoberyl. A silver-white malleable metal. Symbol, Gl; atomic weight, 9.1. Specific gravity, 1.8 (Webster). Called Beryllium by German chemists.

Gluing rock. A ferruginous clay lying above a coal stratum, and which may be mined at the same time as the coal. (Standard)

Glut. 1. (Newc.) A piece of wood, used to fill up behind cribbing or tubbing. (Raymond)
2. A wooden wedge. 3. A small brick or block to fill up a course; also an unburned pressed brick. (Standard)

Glyptic. In mineralogy, exhibiting figures. (Standard)

Glyptography. 1. The art, process, or operation of engraving on precious stones or the like. 2. A description of or treatise on gem-engraving; the knowledge or study of engraved gems. (Standard)

Glyptolith. A faceted pebble polished by wind action. (Lahee, p. 44)

G. M. B. (Eng.). "Good merchantable brand," as applied to copper by the Metal Exchange. (Skinner)

Gmelins blue. *See* Ultramarine, 2.

Gneiss. A layered crystalline rock with a more or less well-developed cleavage, but without the fissility of schist. (U. S. Geol. Surv.) The commonest varieties are mica-gneiss, consisting of feldspar, quartz, and mica; and hornblende-gneiss, consisting of feldspar, quartz, and hornblende. (Roy. Com.)

Gneissic; Gneissoid. Having the appearance or character of gneiss. (Ransome)

Gnomonic projection. A projection made on a plane tangent to a sphere. (A. F. Rogers)

Goaf; Gob. 1. That part of a mine from which the coal has been worked away and the space more or less filled up. 2. The refuse or waste left in the mine. (Woodson)

Goafing. Same as Goaf, 2.

Goaves. Old workings. (Raymond)

Gob. 1. The common American term for goaf. 2. Any pile of loose waste in a mine. 3. To leave coal and other minerals that are not marketable in the mine. 4. To stow or pack any useless underground roadway with rubbish. (Steel)
5. To choke, as a furnace gobs up. (Webster)

Gobbet. A block of stone. (Standard)

Gobbin (Leic.). A contraction of gobbing. *See* Goaf, *also* Gob.

Gobbing. *See* Gob, 3, 4 and 5. The term Gobbing-up is also used synonymously.

Gobbing slate. A thick layer of slate between two seams of coal. The lower seam is mined and the upper seam and the slate shot down, the coal loaded out and then the slate gobbed. (Thacker *v.* Shelby Coal Min. Co., 197 S. W. Rept. p. 633)

Gob entry. A wide entry with a heap of refuse or gob along one side. (Steel)

Gob-fire. Fire originating spontaneously from the heat of decomposing gob (Chance). Also called Breeding-fire.

Gob road (Eng.). A gallery or road extended through goaf or gob. (Gresley)

Gob-road system (Eng.). A form of *the* longwall system of working coal, in which all the main and branch roadways are made and maintained in the goaves. (Century)

Gob room. Space left for stowing gob. (Steel)

Gob stink (Aust.). The odor from the burning coal given off by an underground fire. (Power)

Gob-up (Eng.). *See* Gob, 4 and 5.

Gob wall. A rough wall of flat stones built to prevent the piles of gob from obstructing the passage of air. (Steel)

Go-devil. 1. A scraper with self-adjusting spring blades, inserted in a pipe line and carried forward by the *fluid* pressure, clearing away accumulations from the walls of the pipe. 2. In the oil country this term is also applied to device for exploding the nitro-glycerin used to shoot an oil well. (Redwood)
3. A rude sledge upon which one end of a log is borne, the other end trailing on the ground; tieboy; also a rough, strong wagon used in the woods and about quarries. (Standard)

Godfrey furnace. A furnace with an annular hearth for roasting sulphide ores. Used in Wales. (Ingalls, p. 118)

Godong (Malay). A warehouse; also called Godown.

Godown. A corruption of the Malay *godong*, meaning a warehouse. (Webster)

Goffan; Goffen (Corn.). A long narrow surface-working (Raymond). *See also* Coffin.

Gog (Eng.). A bog. (Standard)

Gogo (Philippines). A plant whose juice is said to catch fine gold. (Lock)

Going (Scot.). Working, *e. g.*, a going place. A room in course of being worked. (Barrowman)

Going bord (No. of Eng.). A bord (room) down which coal is trammed, or one along which the coal from several working places is conveyed into the main haulage. (Gresley)

Going headway. A headway or bord laid with rails, and used for conveying the coal cars to and from the face. (C. and M. M. P.)

Gold. A metallic element of characteristic yellow color. The most malleable and ductile of all metals and one of the heaviest substances known. Symbol, Au; atomic weight, 197.2. Specific gravity, 19.2 to 10.4.

Gold amalgam. 1. A variety of native gold containing mercury. (Standard)
2. *See* Amalgam, 3.

Gold beater. One who makes gold leaf. (Standard)

Goldbeaters' mold. A pack composed of several hundred goldbeaters' skins, having between them partly beaten gold foil to be hammered out into gold leaf. (Standard)

Goldbeaters' skin. The outer coat of the cæcum of the ox, prepared for the use of the goldbeater. (Standard)

Gold brick. A pretended or real brick or bar of gold, sold by a swindler to his victim, to whom is delivered the spurious brick or some substitute for the genuine one; hence, anything purchased as valuable which proves to be almost or quite valueless. (Webster)

Gold digger. One who digs for or mines gold. This word is almost exclusively used to designate placer miners. Those engaged in mining in solid rock are called quartz miners. (Century)

Gold diggings. A region where gold is found mixed with sand or gravel (Standard). *See* Diggings.

Gold dust. Fine particles of gold, such as are obtained in placer mining. An impure dust is sometimes called commercial dust. (Webster)

Golden gate table. *See* End-bump table.

Golden ocher. 1. A native ocher. 2. A mixture of light-yellow ocher, chrome yellow and whiting. (Standard)

Gold fever. A mania for seeking gold: applied specifically to the excitement caused by the discovery of gold in California in 1848–49. (Standard)

Goldfiedite. A sulphantimonide of copper in which part of the antimony is replaced by arsenic and bismuth and part of the sulphur by tellurium. (U. S. Geol. Surv.)

Gold field. A region where gold is found. (Standard)

Gold-filled. Denoting an extra heavy or thick plate of gold on a base metal, as in watch-making. *Compare* Rolled plate. (Standard)

Gold foil. Gold beaten or rolled very thin. (Webster)

Gold latten. 1. Very thin sheet gold. 2. Any thin sheet brass or other metal gilded. (Standard)

Gold mine. 1. A mine containing or yielding gold. It may be either in solid rock (quartz mine) or in alluvial deposits (placer mine). 2. Any investment yielding or furnishing great profit.

Gold purple. Purple of Cassius. (Webster)

Goldschmidt's process. 1. The thermite process of welding. *See* Thermite. 2. The reduction of a metal by mixing its oxide with powdered aluminum and igniting. (Webster)

Goldsmith's window (Aust.). A slang term for a rich mining claim. (Standard)

Gold solder. A kind of solder containing twelve parts gold, two of silver and four of copper. (Webster)

Goldstone. Aventurine in which the gold spangles are very close and fine, giving it the appearance of a natural jewel. *See* Aventurine. (Webster)

Gold telluride. *See* Sylvanite; Calaverite; Krennerite.

Gold wash. A place where gold is washed: used chiefly in the plural. (Standard)

Gold washer. 1. A sweater of gold coin. 2. One who recovers gold by washing away the dirt from auriferous gravel, in a pan, cradle or the like. Also a mechanical device for this purpose. (Webster)

Gold washing. Act or process of washing auriferous soil for gold; also a place where this is carried on (Webster). *See also* Diggings.

Gold work. 1. Act or art of working gold. 2. A place where gold is mined, washed, or worked. (Webster)

Gole. 1. A sluice or floodgate. 2. A small stream; ditch. 3. A hollow between hills; vale. (Standard)

Golpeador (Mex.). The striker, in hand drilling. (Dwight)

Gompholite. *See* Nagelfluh.

Gondola. 1. (U. S.) A long platform railroad car, either having no sides or very low sides. (Webster)
2. A large flat-bottomed river-boat of light build. (Standard)

Gong metal. An alloy from which Oriental gongs are made, as one of 78 parts copper, and 22 parts tin. (Webster)

Góngora (Colom.). A cavity or vug in a lode. (Halse)

Goniometer. An instrument for measuring the angles of crystals. (Webster)

Goodletite (Aust.). The matrix rock in which rubies are found embedded. (Standard)

Good levels (Corn.). Levels nearly horizontal. (Raymond)

Good roasting. Complete roasting. (Raymond)

Good-shooting coal (Ark.). Coal that can be shot "off the solid" with a large proportion of lump coal and little slack. (Steel)

Goose. 1. (Forest of Dean) A water barrel or tub. (Gresley)
2. (Scot.) A platform carrier for handling coal tubs or cars on steeply inclined roads. (Webster)

Gooseberry stone. A pale yellowish variety of garnet included under the term grossularite. (Webster)

Goose brae (Scot.). *See* Cuddy-brae.

Goose-dung ore. An inferior grade of iron sinter containing silver. Called also Goose silver ore.

Gooseneck. A bent pipe or tube having a swivel joint, so that its outer end may be revolved. (Standard)

Goose silver ore. *See* Goose-dung ore.

Goosing (Cal.). In hydraulic mining, driving the gravel forward with the stream from the giant. The reverse of drawing. (Hanks)

Gopher; Gopher-drift. An irregular prospecting drift following or seeking the ore without regard to maintenance of a regular grade or section. (Raymond)

Gopher hole. 1. Same as a coyote hole. It is sometimes used as a designation for any horizontally drilled hole, usually on a level with the mine or quarry floor (Du Pont). (*Bartnes v.* Pittsburgh Iron Ore Co., *143* Northwestern, p. 117; Spino *v. Butler*, 113 Minnesota, p. 326; 129 N. W. Rept., p. 590)
2. A small irregular prospect hole in mining (Standard). *See* Gopher.

Gopher-hole blasting. A term applied in the Middle West and West to a method of blasting rock by means of charges placed in small tunnels driven into the quarry face at floor level. It is known as "tunnel blasting" in the East. (Bowles)

Gophering. Prospecting work confined to digging shallow pits or starting adits. Term used from similarity of this work to the crooked little holes dug in the soil by gophers. (Weed)

Gorge. 1. A narrow passage between hills; a ravine. 2. A jam; as, an ice-gorge. (Standard)

Gorra. (Mex.). A miner's hat of felt, stiffened with pitch. (Dwight)

Gorrón. 1. (Peru) The lower pivot of the vertical shaft in an ore-grinding mill. (Dwight)
2. (Sp.) A round smooth pebble. (Halse)

Goshenite. A colorless beryl. (Dana)

Goslarite. Native white vitriol or zinc sulphate, $ZnSO_4.7H_2O$. (Dana)

Gossan. A ferruginous deposit filling the upper parts of mineral veins or forming a superficial cover on masses of pyrite. It consists principally of hydrated oxide of iron, and has resulted from the oxidation and removal of the sulphur as well as the copper, etc. (Roy. Com.). Also spelled Gozzan. Iron-hat is also a synonym.

Gossaniferous. Containing or producing gossan. (Century)

Gossany lode. A lode filled with gossan. (Power)

Gotear (Mex.). To drip gently; to leak. (Dwight)

Gothic groove. A groove of Gothic-arch section in a roll. (Raymond)

Göthite; Goethite. A hydrous oxide mineral of iron, $Fe_2O_3.H_2O$. (Dana)

Goths (Staff.). Sudden burstings of coal from the face, owing to tension caused by unequal pressure (C. and M. M. P.) The term "air blast" is sometimes used in metal mines, especially in South Africa.

Got-on-knobs (So. Staff.). A system of working thick coal, being a kind of bord-and-pillar plan, the main roadways being first driven to the boundary. (Gresley)

Gotten (Mid.). Said of a worked out or exhausted mine. (Gresley)

Gouge. 1. A layer of soft material along the wall of a vein, favoring the miner, by enabling him after "gouging" it out with a pick, to attack the solid vein from the side (Raymond). *See* Selvage, *also* Flucan.
2. (Nova Scotia) A narrow band of gold-bearing slate next the vein, which can be extracted by a thin, long-pointed stick. (Lock)
3. To work a mine without plan or system. 4. To contract the face of (a mine working) by neglecting to keep the sides cut away. (Standard)

Gouge slip. An oilstone or hone for sharpening gouges or chisels (Century). *See also* Slip stone.

Gouging. In placer mining, an operation similar to ground sluicing. Also called Booming. (Weatherbe)

Gouging shot. A gripping shot or opening shot used to make the first opening in a straight-room face, or to start a break through. *See* Shot. (Steel)

Gounce (Corn.). A frame made of boards in which small tin ore is washed in a stream of water. A strake. (Pryce)

Goutwater (Forest of Dean). Mine water containing hydrogen sulphide, H_2S. (Gresley)

Governor. 1. A device for regulating the speed of an engine or motor under varying conditions of load and pressure. 2. A device for regulating the flow or pressure of a fluid, as gas or water. (Standard)

Gow (Scot.). A blacksmith. (Standard)

Gowan. Decomposed granite. (Standard)

Gowl (Derb.). To break down, as the roof and sides are said to gowl or gowl out when they fall. (Gresley)

Goyazite. Perhaps $Ca_2Al_{10}P_3O_{28}.9H_2O$. In small rounded grains. A yellowish white mineral. From Brazil. (Dana)

Goyder and Laughton process. A flotation process (1905) that was a variation of the Potter-Delprat process. It was used at Broken Hill, N. S. W. (Liddell)

Gozzan (Eng.). *See* Gossan.

Grab. An instrument for extricating broken boring tools from a bore hole. (Gresley)

Grabau process. A method of obtaining aluminum from cryolite. (Goesel, p. 91.)

Graben. A depressed tract of land caused by faults. (Webster)

Grabhooks. Hooks used in lifting blocks of stone. They are used in pairs connected with a chain, and are so constructed that the tension of the chain causes them to adhere firmly to the rock. (Bowles)

Grab iron. *See* Grab.

Grab sample. A sample of ore or coal taken at random, such as may be obtained by taking small amounts at different places on a car or pile of ore or coal.

Grace o' God (Eng.). An accidental discovery of a vein of ore. (Bainbridge)

Grada (Sp.). A single stope; *G. invertida*, an overhand stope; *G. derecha*, an underhand stope. (Halse)

Gradation. In geology, the bringing of a surface or a stream bed to grade, through erosion, transportation, and deposition by running water. (La Forge). *See* Aggradation and Degradation.

Grade. 1. The amount of fall or inclination in ditches, flumes, roads, etc. 2. To prepare a roadway of more uniform slope. 3. A filling made in improving a roadway. (Steel)
4. An ore which carries a great or comparatively small amount of valuable metal is called respectively a high- or low-grade ore. 5. The degree of strength of a high explosive. Those above 40 per cent nitroglycerin are arbitrarily designated as high-grade and those below 40 per cent strength as low-grade dynamites. (Du Pont)
6. In geology, that slope of the bed of a stream, or of a surface over which water flows, upon which the current can just transport its load, without either eroding or depositing. (La Forge)

Graded. In geology, brought to or established at grade, through the action of running water carrying a load of sediment, by eroding or degrading at some places and depositing or aggrading in other places. (La Forge)

Grader. One who or that which grades; a person, implement, or apparatus employed in grading streets, etc., as, a road-grader. (Standard)

Gradient. 1. Rising or descending by regular degrees of inclination. 2. A part of a road which slopes upward or downward; a grade. 3. The rate of increase or decrease of a variable magnitude, or the curve that represents it. (Webster)

Gradienter. A surveyor's instrument, consisting of a small telescope mounted on a tripod and fitted with a spirit level and a graduated vertical arc, used for determining grades, etc. Called also Grading instrument. Sometimes spelled Gradientor. (Standard)

Gradient post. A post or stake indicating by its height or by marks on it the grade of a railroad, highway, or embankment, etc., at that spot (Webster). A grade stake.

Grading test. *See* Screen analysis.

Grado (Mex.). Degree. (Dwight)

Graduador (Mex.). A manometer, or blast gage. (Dwight)

Graduated tile. Roofing tile for covering curved surfaces, such as a round tower, circular bays, and other circular roofs. (Ries)

Graduation. The method or system of dividing a graduated scale; also, one of the equal divisions or one of the dividing lines in such a scale. (Standard)

Graduator. 1. An apparatus for evaporating a liquid by causing it to flow over large surfaces while exposed to a current of air. 2. A dividing engine. (Standard)

Graffito (Italy). In ceramics, pottery decorated with scratches or scorings. Also called Graffito ware. (Standard)

Grafito (Sp.). Graphite; plumbago. (Halse)

Grafting spade (Eng.). A long narrow spade for digging clay. (Gresley)

Grafting tool. A very strong curved spade used in ditch digging. (Standard)

Grahamite. A hydrocarbon resembling albertite in its jet-black luster. Is soluble in carbon disulphide and chloroform but not in alcohol, and is fusible. Occurs in veinlike masses. Specific gravity 1.145. Has conchoidal fracture and is brittle. (U. S. Geol. Surv.)

Grail. Gravel or sand; anything in fine particles. (Standard)

Grain. 1. A second direction of splitting, less pronounced than the rift and usually at right angles to it. (Bowles)
2. (Eng.) Of coal, the lines of structure or parting parallel with the main gangways and hence crossing the breasts. (Raymond)
3. A unit of weight equal to 0.0648 part of a gram, 0.000143 part of an avoirdupois pound, and 0.04167 part of a pennyweight. A grain of fine gold has a value of 4.306 cents or 2.125 pence. (Lindgren, p. 20)
4. In petrology, that factor of the texture of a rock composed of distinct particles or crystals which depends upon their absolute size. (La Forge)

Grain gold. Gold that has become granular in the process of heating. (Standard)

Grain tin. 1. (Corn.) Crystalline tin ore (Raymond). Oxide of tin in the form of grains or pebbles. (Hunt)
2. The purest and finest white tin, smelted with charcoal. (Century)

Graith; Grathe. 1. (No. of Eng.) To replace, repair, dress, or put in order (Gresley). Probably a variation of grade.
2. (Scot.) A miner's tools; horse harness. (Barrowman)

Gram; Gramme. A unit of weight in the metric system equal to 15.432 grains, 0.643 pennyweight, 0.03215 troy ounce, 0.035274 avoirdupois ounce, and has a fine gold value of 66.45 cents or 2.73275 shillings. (Lindgren, p. 20)

Gram-centimeter. A unit of work; the work done in raising the weight of one gram vertically one centimeter; 981 ergs. (Standard)

Gram-degree. Same as Calory (Standard). *See* Calorie.

Grammatite. Same as Tremolite. (Standard)

Grampus (U. S.). The tongs with which bloomery loups and billets are handled. (Raymond)

Granada (Sp.). Garnet. (Halse)

Granalla (Sp.). Grains of metal; filings; grains of melted gold found in Indian graves. (Halse)

Granate. 1. (Sp.) Garnet; a synonym for Granada. 2. (Mex.) Crystallized cinnabar. (Halse)

Granceo (Sp.). The operation of crushing ore. (Halse)

Graniform. Formed like a grain; composed of grains or granules. (Standard)

Granite. 1. A granular igneous rock composed essentially of quartz, orthoclase or microcline, and mica. Commonly a part of the feldspar is plagioclase. The mica may be either biotite or muscovite or both. Hornblende is a common, and augite an uncommon, component. Apatite, zircon, and magnetite are always present, generally as very small individuals. Commercially, almost all compact igneous rocks are called granite as distinguished from slate, sandstone, and marble. (U. S. Geol. Surv.)

Granite family. The group of crystalline, homogeneous or non-foliated rocks resembling granite, such as syenite, quartz-syenite, granitite, and all varieties of granite itself. (Roy. Com.)

Granitelle. A granite with comparatively little mica, so that it consists almost entirely of quartz and feldspar; binary granite. It has been also used by R. D. Irving for augite-granite. (Kemp)

Granite-porphyry. Practically a quartz-porphyry with a coarsely crystalline groundmass and preponderating phenocrysts. The chief phenocrysts are, however, feldspar. (Kemp)

Granite ware. 1. A fine, very hard pottery resembling ironstone china. 2. Pottery having a variegated surface resembling or suggesting the markings of granite. (Standard)
3. A kind of ironware, coated with an enamel suggesting granite. (Webster)

Granitic. Characteristic of, composed of, pertaining to, or resembling granite. (La Forge)

Graniticoline. Growing upon or attached to granite, as lichens. (Century)

Granitification. The act of forming into granite, or the state or process of being formed into granite. (Century)

Granitite. Biotitic granite. It is much the commonest of the granites. (Kemp)

Granito (Sp.). Granite. (Halse)

Granitoid. A textural term to describe those igneous rocks which are entirely composed of recognizable minerals of approximately the same size. It was suggested by granite, the most familiar of the rocks which show this characteristic. In the granitoid texture each kind of mineral appears in but one generation, and the individuals seldom have crystal boundaries (Kemp). *See also* Granular.

Grano (Sp.). A grain; *G. de oro*, a grain of gold. (Halse)

Granodiorite. A term which has been given special currency by the usage of the U. S. Geological Survey, and which is employed for the intermedite rocks between granites and quartz-diorites. It is a contraction for granite-diorite and is a very useful rock name. *Compare* Adamellite. (Kemp)

Granolith. An artificial stone of crushed granite and cement used for paving. (Webster)

Granophyre. A descriptive term used in connection with microscopic study to describe those groundmasses in quartz-porphyries and microgranites in which the quartz and feldspar crystals have simultaneously crystallized so as to mutually penetrate each other. Micropegmatitic is synonymous (Kemp). The term is but little used.

Granophyric. In petrology, porphyritic with a granular groundmass. (La Forge)

Grant (Eng.). A tract of land leased or ceded for mining purposes. (Pryce)

Granular. Composed of approximately equal grains, either crystalline in outline or rounded by attrition; specifically, in igneous rocks, composed of grains of constituent minerals, each of which has been formed in but one definite stage of the crystallization. (Standard)

Granular quartz. Same as Quartzite. (Dana)

Granulate. To form into grains or small particles, as gunpowder, zinc, etc. (Standard)

Granulated. In ceramics, stippled with a brush in imitation of granules; spotted; mottled. (Standard)

Granulated steel. Steel made from pig iron by a process in which the first step is the granulation of the iron. (Standard)

Granulating machine. 1. A device for reducing metal in a liquid form to fine grain. In a common method the hot metal is dropped on the face of a rapidly revolving disk, which scatters it centrifugally in minute particles. 2. An apparatus for reducing a powder cake to gunpowder. (Standard)

Granulation. 1. The state or process of being formed into grains or small particles. From Latin *granum*, a grain (Rickard). A term used in metallurgy.
2. The process of separating into various sizes the particles of blasting powder. (Du Pont)

Granule. A little grain; a small particle. (Webster)

Granulite. Properly speaking, a moderately fine-grained metamorphic rock composed chiefly of quartz and feldspar, but commonly containing some garnet (La Forge). Sometimes the name is less correctly used for muscovite granite, or for granites containing little else than quartz and feldspar (Kemp). *Compare* Whitestone, 2.

Granulitic. In petrology, characteristic of, composed of, pertaining to, or resembling granulite. (La Forge)

Granza. 1. (Sp.) In California quicksilver mining, second-grade ore obtained in small lumps. (Standard)
2. (Mex.) Any metallic mineral from the size of rice to that of hen's eggs (Dwight). Used in the plural.

Granzear (Mex.). To crush ore into a fine powder by two large stones. (Halse)

Graphic. In petrology, characterized by the mutual interpenetration, commonly in parallel orientation, of the crystals of two minerals, especially quartz and feldspar; said of the texture of some igneous rocks. (La Forge)

Graphic gold. Crystals of sylvanite arranged regularly so as to simulate symbols (Standard). Called also Graphic tellurium.

Graphic granite. A variety of binary granite in which the quartz is disposed in the feldspar in such a way that in cross section it has some resemblance to Hebrew and cuneiform writing, and from this circumstance derives its name. (Roy. Com.)

Graphic ore. Same as Sylvanite. (Standard)

Graphic tellurium. *See* Graphic gold.

Graphite. 1. A soft, steel-gray to black, more or less impure, native form of carbon (U. S. Geol. Surv.). The name of the mineral is often prefixed to the names of rocks containing it, as graphite-gneiss, graphite-schist, etc. (Kemp)
2. Called also black lead and plumbago, because it is used for marking, although lead does not enter into its composition.

Graphitic carbon. That portion of the carbon in iron or steel which is present as graphite. (Raymond)

Grapholite. Any species of slate suitable to be written on. (Webster)

Graplin. *See* Grapnel, 2.

Grapnel. 1. An implement for removing the core left by an annular drill in a bore hole, or for recovering tools, fragments, etc., fallen into the hole. (Raymond)
2. A small anchor with four or five flukes or claws; a grappling iron. (Webster)
3. A heavy tongs used in handling large logs, stones, etc. (Standard)

Grappel. *See* Grapnel, 1.

Grappling iron. An instrument consisting of several iron or steel claws for grappling and holding fast to something. (Century). *See also* Grapnel, 1.

Grasa (Mex.). Slag from smelting operations. (Dwight)

Grasero (Mex.). Slag pile. (Dwight)

Grass (Corn.). The surface over a mine. Bringing ores to grass is taking them out of the mine. (Raymond)

Grass captain (Eng.). An overseer of the workmen above ground (Pryce). A surface foreman.

Grass crop (Scot.). The outcrop of a vein. (Barrowman)

Grasshopper engine (Scot.). A beam engine having one end of the beam supported on a rocking fulcrum. (Barrowman)

Grass roots. A miner's term equivalent to the surface (Roy. Com.) 'From grass roots down' is from the grass roots to the bed rock. (Martin *v.* Eagle Dev. Co., 41 Oregon, p. 456; 69 Pacific, p. 216)

Grate. 1. (Corn.) *See* Screen, 1, as applied to stamps. (Raymond)
2. A frame, bed, or a kind of basket of iron bars for holding fuel while burning. (Webster)

Grate bar. 1. A bar forming part of a fire grate. (Standard)
2. One of the bars forming a coarse screen or grizzley.

Grate coal. Coal which will pass through bars 3¼ to 4¼ inches apart and over 2¼-inch round holes; also called Broken coal. In Arkansas the bars are 7 inches apart and the holes 3 inches to 3¼ inches in diameter. (Steel)

Grate room. A compartment of a glass furnace, with grated bottom for holding the fire. (Standard)

Grate surface. The area of the surface of the grate of a steam boiler, or any part of it. (Standard)

Grating. 1. The plate of perforated metal, or a wire sieve, fixed in the openings in mortar of stamp mills (Roy. Com.). A heavy screen.
2. The act of sorting ores by passing them through grates. (Standard)

Gravel. Small stones and pebbles or a mixture of sand and small stones; more specifically, fragments of rock worn by the action of air and water, larger and coarser than sand. (U. S. Geol. Surv.)

Gravel mine. A placer mine; a body of sand or gravel containing particles of gold. (Skinner) *See also* Gravel pit.

Gravel pit. A pit from which gravel is obtained. (Standard)

Gravel plain (tundra) placers. Placers along the coastal plain of Seward Peninsula, Alaska. (U. S. Geol. Surv. Bull. 259, p. 33)

Gravel powder. Very coarse gunpowder. (Standard)

Gravel stone. A pebble; a calculus. (Webster)

Gravel wall (War.). The junction of a coal seam with overlapping, or unconformable, rocks. (Gresley)

Grave-wax. *See* Hatchettite.

Graveyard shift. A term used in the Western States for the night shift, usually beginning at 11 o'clock p. m. *See* Dying shift; *also* Dog-watch.

Gravimeter. 1. An instrument for measuring the force or acceleration of gravity. Called also Gravity meter. 2. An instrument of determining specific gravities, particularly of liquids. *See* Hydrometer. (Standard)

Gravimetric analysis. The quantitative determination of the constituents of a compound by weight; contrasted with Volumetric analysis. (Standard)

Gravitation. *See* Law of gravitation.

Gravity battery. In electricity, a two-fluid battery in which the fluids are separated by their different specific gravities. (Standard)

Gravity fault. *See* Fault.

Gravity plane. A tramline laid at such an angle that full skips running down hill will pull up the empties. (Power)

Gravity railroad. A railroad in which the cars descend by their own weight; an inclined railroad. (Standard)

Gravity solution. A solution used to separate the different mineral constituents of rocks by their specific gravities, as the solution of mercuric iodide in potassium iodide having a maximum specific gravity of 3.19. (Standard)

Gravity stamp. A stamp, usually set in batteries of five, in which the piston is raised by a cam, the stamp crushing the charge in the mortar by its weight, when allowed to fall. (Weed)

Gray antimony. *See* Stibnite.

Grayback (Aust.). A local name for minor cleats that cross the main cleat. (Power)

Grayband. A variety of sandstone for sidewalks; flagstone. (Standard)

Gray beds (No. of Eng.). A stratum formed by a mixture of shale and sand. (Power)

Gray cobalt. Smaltite.

Gray copper. *See* Tetrahedrite.

Grayheads (Aust.). Joints in the rolling country of the Southern Coalfield of N. S. W., which run parallel with the longer axis of a roll; these joints are generally coated with a whitish substance. (Power)

Gray hematite. *See* Specularite.

Gray iron. A cast iron containing much graphitic carbon. (Standard)

Gray manganese. *See* Manganite.

Gray metal. Shale of a grayish color. (C. and M. M. P.)

Gray ore (Corn.). Copper glance. *See* Tetrahedrite. (Raymond)

Gray post (Eng.). Sandstone of a gray color. (G. C. Greenwell)

Grays (Som.). Hard siliceous sandstone. (Gresley)

Gray slag. The slag from the Flintshire lead furnace. It is rich in lead. (Raymond)

Gray's tester. An instrument used for determining the flashing point of heavy oils. (Mitzakis)

Graystone. A grayish, or greenish, compact rock, composed of feldspar and augite and allied to basalt. (Webster)

Graywacke; Grauwacke. 1. An old name of loose signification, applied to metamorphosed, shaly sandstones that yield a tough, irregularly breaking rock, different from slate on the one hand and from quartzite on the other. The components of graywacke may be largely bits of rocks, rather than fragments of minerals. (Kemp)
2. A variety of sandstone containing abundant grains of biotite, hornblende, magnetite, etc. (La Forge)

Graywacke slate. Micaceous and sandy, fine-grained, slaty, or shaly rocks: formerly so-called. (Standard)

Graywether. One of numerous fragments or blocks of sandstone and conglomerate, covering large tracts in Dorsetshire and Wiltshire, England, supposed to be remnants of eroded Tertiary strata. Called also Druidical, Sarsen, and Saracen stones. (Standard)

Grazón. 1. (Sp.) A fragment of ore which does not pass through a screen. 2. (Venez.) Pisolitic brown hematite. (Halse)

Grease. 1. Properly speaking, this term should only be applied to fatty or oily matter of animal origin; but mixtures of mineral oil with lime- and soda-soaps constitute well-known lubricating greases. (Bacon)
2. Animal fat when soft. Also anything oily or unctuous. From the French *graisse*. A term used in the flotation process. (Rickard)

Grease box. A box containing fat or grease to lubricate a bearing. (Webster)

Grease pot. The third of a series of vats used in tinning sheet-iron or steel. (Standard)

Greaser. 1. A person who oils or greases the mine cars. (Steel)
2. An automatic apparatus which greases the axles of skips as they pass. (Power)
3. A slang name for a Mexican or Spanish-American. (Webster)

Greasy. Applied to the luster of minerals. Having the luster of oily glass, as elaeolite. (Dana)

Greasy bleas (Scot.). *See* Creeshy bleas.

Greasy gold. Fine gold. (Megraw, p. 2)

Greasy quartz. Milk quartz. (Power)

Great coal (Scot.). Large pieces of selected coal. In the East of Scotland, the coal was formerly divided into four grades, great coal, chews, lime coal, and panwood. (Barrowman)

Greave. A ditch. (Standard)

Greda. 1. (Sp.) Fuller's earth; a soft friable earth which absorbs grease. 2. Marl, chalk. 3. (Venez.) Pay gravel; alluvial gold. 4. (Colom.) A carboniferous schist containing nodular pieces of iron ore. (Halse)

Grede (Venez.) A yellow iron-stained clay. (Duryee)

Greek (Scot.). Grit; the texture of a hard rock; coarse sandstone. (Barrowman)

Greek masonry. A style of masonry in which each alternate stone is of the full thickness of the wall. (Standard)

Green carbonate of copper. *See* Malachite.

Green charge. A mixture of ingredients for gunpowder before the intimate mixing in the incorporating mill. (Webster)

Green cinnabar. A green pigment consisting of the fired oxides of cobalt and zinc. (Webster)

Green coal (Aust.). Freshly mined coal. (Power)

Green copperas; Green vitriol. The mineral melanterite, a hydrous ferrous sulphate, $FeSO_4+7H_2O$.

Green earth. 1. Glauconite, found in cavities of amygdaloids and other eruptive rocks, and used as a pigment by artists. (Webster)
2. Chlorite; a variety of talc. (Humble)

Green feldspar. A synonym for Amazon stone; microcline. (Chester)

Green hole. A furnace tap hole in which clay is not properly set, and through which the drill may break and let iron out unexpectedly. (Willcox)

Greenhouse. In ceramics, a moderately warmed building for partly drying green pottery. (Standard)

Green iron ore. The mineral dufrenite; aproximately, $FePO_4.Fe(OH)_3$. (Dana)

Green lead ore. *See* Pyromorphite.

Green marble. A commercial term for serpentine.

Green mineral. Green carbonate of copper; malachite. (Standard)

Green ocher. A yellow ocher mixed with potassium ferrocyanide. (Standard)

Greenockite. Cadmium sulphide, CdS. Contains 77.7 per cent cadmium. Greenockite occurs as a secondary mineral in zinc deposits in various parts of the United States, but not as a commercial deposit at any place. The majority of sphalerite deposits are cadmiferous, and cad-

mium in commercial quantity is obtained as a by-product in smelting these ores at certain plants. (U. S. Geol. Surv.) *See* Furnace cadmium.

Green oil. In the Scottish shale-oil industry, the once-run crude oil after chemical treatment. It is distilled in the first-stage oil stills and is fractioned into naphtha, light oil, heavy oil, and heavy oil and wax. (Bacon)

Green roof. A miner's term for a roof which has not broken down or shows no sign of taking weight. (Gresley)

Greenroom. A chamber for the reception of unburned and undried pottery. (Standard)

Greensand. Sedimentary deposit consisting, when pure, of grains of glauconite, which have a dark greenish color. (Webster)

Green sand. A highly siliceous sand containing a little magnesia and alumina, mixed with about one-twelfth its bulk of powdered coal or charcoal, used when dampened for making molds; distinguished from dry sand (Webster). An unburned molding sand.

Greensand beds. In general, any Cretaceous or Tertiary bed containing a green iron-potassium silicate; specifically, the Lower Cretaceous of England, whether containing the green silicate or not. (Standard)

Greensand marl. Sand or marl containing glauconite (U. S. Geol. Surv.). *See* Greensand; Marl.

Greensand of Peru. An early synonym for Atacamite, because found there in the form of sand. (Chester)

Greenstone. An old field name for those compact, igneous rocks that have developed enough chlorite in alteration to give them a green cast. They are mostly diabases and diorites. Greenstone is partially synonymous with trap. It is often used as a prefix to other rock names (Kemp). The term is used frequently when no accurate determination is possible.

Green tar. Barbados petroleum. (Bacon)

Green verditer. *See* Verditer, 2 and 3.

Green vitriol. Ferrous sulphate; copperas, melanterite. Called also Martial vitriol. (Standard)

Green ware. Damp, recently made, unburned pottery, requiring to be dried before burning or baking. (Standard)

Greillade (Fr.). Iron ore in coarse powder, mixed with charcoal dust for reduction by the Catalan process. (Webster)

Greisen. A granitoid but often somewhat cellular rock, composed of quartz and muscovite or some related mica, rich in fluorine. It is the characteristic mother rock of the ore of tin, cassiterite, and is in most cases a result of the contact action of granite and its evolved mineralizers. (Kemp)

Greña (Mex.). Undressed ore. (Dwight)

Grenate. Garnet (Standard). Also spelled Grenat.

Grès (Fr.). 1. Grit. 2. Sandstone. 3. Stoneware. (Standard)

Grès cérame; Grès de Flandres (Fr.). A fine German stoneware, usually with a salt glaze, not made specially in Flanders, but in Coblentz and Cologne. (Standard)

Greve. A ditch or trench. (Standard)

Grewt. An earth of different color from that of the main deposit, found in searching for mines on the banks of rivers (Standard). Also spelled Greut. A variation of groot, meaning soil.

Grey wethers (Eng.). *See* Graywether.

Grid. 1. A grated opening. 2. A section of electrical resistance, usually made of cast iron. (C. and M. M. P.)
3. A wire-bottomed mining sieve.
4. A battery plate somewhat like a grating; specifically, a zinc plate in a primary battery, or a lead plate, either perforated or furnished with depressions, for retaining the active material in a storage battery. (Standard)

Gridaw (So. Wales). Pulley frames or head gear. (Gresley)

Griddle; Riddle. 1. (Corn.) A miner's sieve to separate ore from halvans. (Raymond)
2. To screen ore with a griddle. (Webster)

Gridiron twinning. *See* Crossed twinning.

Gridiron valve. A slide valve having many ports corresponding to ports in the seat. (Standard)

Grieta (Mex.). A crevice; fissure. (Dwight)

Grieve. 1. (Scot.) A weigher; a pit-headman; a hill salesman. (Barrowman)
2. A manager; an overseer. (Webster)

Grif (Eng.). A steep, rocky glen. (Standard)

Griffin roller mill. A centrifugal mill, like the Huntington, except there is one roller only. *See* Huntington mill. (Liddell)

Grillo furnace. A mechanically-fed muffle furnace. (Ingalls, p. 130)

Grimes (So. Wales). *See* Bell mold.

Grind. 1. To reduce to a powder by friction as in a mill. 2. To polish or sharpen by friction. (Webster)

Grinder. One who or that which *grinds*, as an emery wheel for grinding tools, a machine for crushing ore, etc. (Webster)

Grinders' asthma, rot, or phthisis. Disease of the lungs consequent upon inhaling the metallic dust produced in grinding metals. (Standard)

Grinding bed. A machine for grinding stone slabs, consisting of a laterally moving table on which the slab is placed, and a heavy rotating iron disk, whose lower surface abrades or polishes the upper surface of the stone. (Standard)

Grinding bench. A stone slab on which to fasten by plaster of Paris, in a level position, a plate of glass the upper surface of which is to be ground or polished. (Standard)

Grinding lathe. A lathe of special construction in which the work revolves on dead centers while acted on by an emery wheel. (Standard)

Grinding plate. 1. A piece of steel or iron by the medium of which ore is ground against another hard surface. (Rickard)
2. A heavy cast iron disk rotating on a vertical axis, used to grind or polish plate glass. (Standard)

Grinding slip. A free-cutting oilstone or whetstone; a hone. (Standard)

Grinding vat. A mill for grinding flints or clay used in making porcelain. It is a form of the arrastre. (Century)

Grindlet. A little ditch or drain. (Standard)

Grindstone. 1. A tough sandstone of fine and even grain, composed almost entirely of quartz, mostly in angular grains. It must have sufficient cementing material to hold the grains together but not enough to fill the pores and cause the surface to wear smooth. (U. S. Geol. Surv.)
2. A large circular stone made from sandstone and used quite extensively for the sharpening of many different tools and instruments. (Pike)

Grindstone grit. A kind of grittty rock from which grindstones are made. (Standard)

Gringo. In Spanish America, any one of English blood or speech: a contemptuous epithet. (Standard)

Griotte marble. A French marble of a beautiful red color and often varigated with small dashes of purple and spots or streaks of white, as in the variety locally known as *griotte oeil de perdrix* from the French Pyrenees. (Merrill)

Grip. 1. A small, narrow cavity. (Raymond)
2. To turn into the side of a working place. (Steel)
3. A notch cut into the side of a mass of stone, into which a wedge may be driven to separate the mass (Bowles). Also called Side shear.
4. (Scot.) A pick. (Barrowman)
5. An apparatus attached to a car for clutching a traction cable. 6. A gripsack or valise. (Webster)
7. (Eng.). To dig trenches or drains in. 8. A grappling tool for drawing up well-boring rods. (Standard)

Gripe. A strap brake or ribbon brake on hoisting apparatus. (Standard)

Griper (Eng.). A Thames coal-barge or collier. (Standard)

Gripper. A claw of a submarine dredger. (Standard)

Gripping shot. A shot so placed that the point or inner end of the hole is considerably farther from the face of the coal to be broken than is the heel or outer end of the hole. *See also* Shot.

Grip wheel. A wheel, the periphery of which is fitted with a series of toggle-jointed, cast-steel jaws that grip the rope automatically. (C. M. P.)

Grison stone. A gray freestone. (Webster)

Grisou (Fr.). Fire damp.

Grist (So. Wales). A black, coaly stratum, indicating a probable bed of coal not far off. (Gresley)

Grisú (Sp.). Fire damp. (Lucas)

Grit. 1. In petrology, a sandstone composed of coarse, angular grains and very small pebbles. (La Forge)
2. An artificial stone for sharpening tools. Standard grades are coarse, medium, and fine. Coarse stones cut very rapidly, but leave a rough edge. Medium stones do not cut as fast as coarse stones but leave a smoother edge. Fine stones are still slower cutting, but are useful where extremely fine edges are desired. (Pike)
3. Rough, hard particles; sand or gravel. 4. Degree of hardness with openness of texture or composition; allied to buhrstone and the like. (Standard)

Grizzle. 1. (Eng.) Inferior coal with an admixture of iron pyrite. (Gresley)
2. A second-rate brick, underburnt, gray in color, and deficient in strength. (Webster)

Grizzly. 1. (Cal.) An iron grating that catches the larger stones passing through the sluices and throws them aside. (Hanks)
2. A grating of iron or steel bars for screening ore, etc. (Webster)
3. Guard rails or covering to protect chutes, manways, winzes, etc., in mines. (Montana Stat., Laws, 1911, Sec. 3)

Grog. Ground up pieces of burned clay or brick, added to the raw clay mixture for the purpose of decreasing the shrinkage and density of the burned ware. (Ries)

Groin (Eng.). A structure of piling, sometimes with a stone apron at the end, to accumulate sand and shingle on a beach, and to act as a breakwater. (Standard)

Gröndal magnetic separator. A device utilizing a magnetic field for the concentration of certain magnetic ores. It consists of a vertical revolving cylinder made up of rings of cast iron with the spaces between containing the wires for the electric current. Each ring is so magnetized as to be a little stronger than the one above. There is another cylinder of wood studded with soft wrought-iron pegs, a ring of pegs being opposite each cast-iron ring. The magnetic portion of the ore (usually crushed below 12 mesh) is carried around on the cast-iron rings until it gets near the pegs, to which it jumps because of their induced magnetism. It is then carried on these pegs out of the magnetic field and thrown off. (Liddell)

Groove. 1. (Derb.). The place where a miner is working. Miners are (1747) called groovers. (Hooson)
2. A mine, from the German *Grube*. (Raymond)

Groove fellow (No. of Eng.). A mate or fellow workman in a mine. (Standard)

Groover (No. of Eng.). A miner. (Standard)

Groroilite. A nearly black earthy manganese or wad, streaked with dark-red markings, occurring in parts of Europe. (Standard)

Grorudite. Brögger's name for a porphyritic, dike rock from Grorud, near Christiania, Norway. The phenocrysts are microcline and aegirite; the groundmass consists of rectangular orthoclase, quartz and aegirite. It is a variety of granite porphyry. (Kemp)

Gros morceaux (Belg.). Coal in very large lumps. (Gresley)

Gross ton. The long ton of 2240 pounds avoirdupois.

Grossularite. Calcium-aluminium garnet, $3CaO . Al_2O_3 . 3 SiO_2$; cinnamon stone. (Dana)

Grotto. A small cavern or a cavern-like apartment or retreat, natural or artificial; especially, a cavern having some attractive features, as beautiful stalactite formations, or rockwork. (Standard)

Grouan (Corn.). Gravel, rough sand. Also called Gowan. *Hard grouan* is granite or moorstone. *Soft grouan* is the same material in a lax and sandy state. *Grouan lode*, any tin lode which abounds with this gravel. (Pryce)

Grouder (Corn.). A mixture of grouan and clay, used for scouring wood work. (Pryce)

Ground. 1. (Corn.) The rock in which a vein is found; also, any given portion of the mineral deposit itself. (Raymond)
2. In electricity, a connection with the earth. A ground plate. (Standard)

Ground air. Air inclosed in porous surface soil, like surface moisture or ground water. (Century)

Ground bailiff (Eng.). An inspector or superintendent of a mine. (Standard)

Ground block; Ground crab (Eng.). A species of capstan used for lowering the sinking pumps. (Gresley)

Ground circuit. An electric circuit completed by the ground; an earth circuit. (Standard)

Ground coal; Grounds (Scot.). The bottom of a coal seam. (Barrowman)

Ground crab. *See* Ground block.

Ground detector. A device, as in a central power station, to indicate where a ground connection, entailing loss of electricity, has taken place. (Standard)

Grounded circuit. A circuit that is permanently grounded at one or more points. (H. H. Clark)

Ground hog. *See* Barney.

Ground ice. Ice which sometimes forms on the bottom of either running or still waters. It often has stone and mud attached to its bottom (Webster). Also called Anchor ice.

Grounding. 1. *See* Ground, 2.
2. In marble-working, the act or process of polishing marble with emery. 3. *See* Ground-laying. (Standard)

Ground laying. In ceramics, the process of applying a coat of boiled oil to porcelain ware, to receive the colored enamel; bossing; grounding. (Standard)

Groundman. A man employed to work on the ground, as in digging or excavating. (Webster)

Groundmass. The relatively finely crystalline, or glassy, portion of a porphyritic rock as contrasted with its phenocrysts. Not to be confounded with *basis*, as will be seen by referring to the latter. (Kemp)

Ground moraine. In geology, the irregular sheet of till deposited partly beneath the advancing glacier and partly directly from the ice when it melts away. (La Forge)

Ground plate. 1. A groundsill. 2. A bedplate supporting railroad sleepers or ties. 3. In electricity, a metal plate in the ground forming the earth connection of a metallic circuit. (Standard)

Ground rent (Eng.). Rent paid for the surface occupied by a colliery plant. (Gresley)

Ground return. That part of an electric circuit as the earth, or metallic conductors intimately associated with the earth, and which is practically at earth potential at all points. (H. H. Clark)

Ground rope (Scot.). The rope connecting hanging pumps to a ground crab. (Barrowman)

Groundsel. *See* Groundsill.

Groundsill. A bed piece or foundation timber supporting a timber superstructure as a set of mine timbers. A ground plate. (Webster)

Ground sluice. 1. A channel or trough in the ground through which auriferous earth is sluiced for placer mining. 2. To wash down a bank of earth with a stream of water. (Webster)

Ground spears. Wooden rods (one on each side of the pump) by which a sinking pump is suspended. (Gresley)

Groundstone. A foundation; groundwork. (Webster)

Ground water. The water which permeates, in an unbroken sheet, the rock masses of the earth, filling their pores and fissures.

Ground-water discharge. The return of ground water to the surface. (Meinzer)

Ground-water divide. The crest line of a water table. On the opposite sides of this line the water table slopes in opposite directions (Meinzer). *Compare* Watershed.

Ground-water level. The level below which the rock and subsoil, down to unknown depths, are full of water. (Chamberlin, vol. 1, p. 67)

Groundwork. The foundation work of a structure. (Standard)

Group. 1. In geology, commonly and loosely, the unit of stratigraphic classification. 2. Specifically, (*a*) in the usage of the U. S. Geological Survey, two or more associated formations formerly regarded as one but now separated in some areas; (*b*) according to the International Geologic Congress, the stratigraphic division of highest rank, coordinate with era. (La Forge)

Grouser. A temporary pile or heavy iron-shod pole driven into the bottom of a stream to hold a drilling or dredging boat or other floating object in position. (Century)

Grout. 1. A term applied to the waste material of all sizes obtained in quarrying stone. (Perkins)
2. (Eng.) Thin mortar poured into the interstices between stones and bricks. (C. and M. M. P.)
3. A coarse kind of plaster or cement, usually studded with small stones after application, sometimes used for coating walls of a building. (Webster)
4. A thin cement mixture forced into the crevices of a stratum or strata to prevent ground water from seeping or flowing into an excavation. Frequently employed in shaft sinking and bore-hole drilling.

Grouting. 1. The process of filling in or finishing with grout. 2. The grout thus filled in. (Century)

Grove; Groove (Eng.). A drift or adit driven into a hillside from which coal is worked (G. C. Greenwell). *See also* Groove. 1 and 2.

Growan; Grouan (Corn.). A name applied by miners to granite and similar rocks. (Ure) *See also* Grouan.

Growl (Mid.). Coal pillars are said to growl when they are undergoing a crushing weight. (Gresley)

Grow-on. Quarrymen's term to designate the place where the sheet structure dies out, or the place where two sheets appear to grow onto one another. (Perkins)

Growth (Scot.). The rate of entrance of water into a pit or mine working. (Barrowman)

Groze (Scot.). To turn a chisel in the bottom of a bore hole, by which means the borer, from a sense of feeling and hearing, knows when a change of strata occurs. (Barrowman)

Grozing iron. 1. A steel tool formerly used for cutting glass. 2. A bulbous tool for smoothing the soldered joints of lead pipe. (Webster)

Grubbin. *See* Gubbin.

Grube (Ger.). A mine. (Davies)

Grub saw. A saw made from a coarsely notched blade of soft iron, provided with a wooden back; used, with sand, for sawing stone by hand power. (Standard)

Grubstake (West. U. S.). Supplies furnished to a prospector on promise of a share in his discoveries. So called because the lender stakes or risks the grub (food), etc., so furnished. (Webster)

Grubstake contract. An agreement between two or more persons to locate mines upon the public domain by their joint aid, effort, labor, or expense, and each is to acquire by virtue of the act of location such an interest in the mine as agreed upon in the contract. (Marks *v.* Gates, 2 Alaska, p. 524; Cascaden *v.* Dunbar, 2 Alaska, p. 412; Berry *v.* Woodburn, 107 California, p. 504; Meylette *v.* Brennon, 20 Colorado, p. 242; Hartney *v.* Gosling, 10 Wyoming, p. 346; 68 Pacific, 1123; Elliott *v.* Elliott, 3 Alaska, p. 365)

Gruell (Irish). Coal. (Standard)

Grueso (Sp.). Lump ore. The term is in use at the quicksilver mines of California. (Raymond)

Gruff (Eng.). A name given to an old mine on the Mendip Hills (Hunt). A pit or shaft.

Grunching (Aust.). Shooting-fast, *i. e.*, shooting in the solid. (Power)

Grundy. Granulated pig iron used in making granulated steel. (Webster)

Grunstane (Scot.). A grindstone. (Standard)

Grunter. A hooked rod to aid in supporting a crucible (Standard). A founder's term.

Grupiaras (Braz.). Bench placers on the slopes of hills. (Halse)

Guaca. 1. (Sp. Am.) A narrow tunnel or drift in a hill. 2. (Peru) An ancient Indian grave. (Halse)

Guadalcazarite (Sp.). A variety of cinnabar containing zinc. (Standard)

Guag (Corn.). A place from which the ore has been extracted (Davies). A variation of gwag.

Guaira (Peru). A wind furnace made of clay, used by the Indians for smelting ores. (Halse)

Guairona (Peru). Guard rails at mouth of a shaft. (Dwight)

Guaje (Mex.). A gourd for dipping water. (Dwight)

Gualda (Peru). Chalcopyrite. (Halse)

Gualdra (Mex.). Long and stout beam, generally sustaining other beams, or a heavy weight. (Dwight)

Guano. A substance found in great abundance on some coasts or islands frequented by sea fowls and composed chiefly of their excrement. It is rich in phosphates and nitrogenous matter. (Webster)

Guaquero (Colom.). One who searches for treasure in Indian graves, or *guacas*. (Halse)

Guarache (Peru). 1. Overtime work, generally at night. 2. A sandal. (Dwight)

Guaraci (Sp. Am.). Basalt; diorite. (Lucas)

Guard. 1. A support in front of a roll-train to guide the bar into the groove, sometimes called a side-guide. (Raymond)
2. Any fixture or attachment designed to protect against injury. 3. To protect from danger; to keep in safety; to defend. (Webster)

Guarda. 1. (Sp.) A thin parting between a lode and the wall rock. (Davies)
2. (Mex.) Immediately adjacent country rock. 3. A guard. (Dwight)

Guardafierros (Mex.). A tooolman. (Dwight)

Guardaraya (Mex.). 1. Landmark; monument. 2. The end and side lines of a mining claim (Dwight). 3. A surveyor's mark used underground for measuring work. (Halse)

Guardatiro (Mex.). Person issuing mining supplies to the miners. (Dwight)

Guard plate. A plate in front of an iron furnace, covering the tap hole through which the slag is drawn out. (Standard)

Guard rail. An additional rail placed beside the rail in service, to compel the flange of the wheels to run close to the latter in crossing over frog points or entering switches. (Century)

Guayaquillite. A pale yellow, amorphous, nonresinous, oxygenated hydrocarbon, from near Guayaquil, South America; it has the specific gravity 1.092, begins to fuse at 70° C., and is soluble in alcohol. (Bacon)

Gubbin (Eng.). An argillaceous iron ore, found in Staffordshire, England (Standard). Sometimes spelled Grubbin.

Gudgeon. 1. An iron pin to fasten together blocks of stone. (Webster)
2. (Eng.) A bit of wood used for roofing a mine. (Bainbridge)
3. The bearing of a shaft, especially when made of a separate piece. 4. A metallic journal set into the end of a wooden shaft. (Standard)

Güedales (Mex.). Irregular contact veins of copper ore occurring in porphyry. (Halse)

Gueulette (Fr.). In glass making, the back door of an annealing oven. (Standard)

Gug (Som.). A self-acting inclined plane underground; sometimes called a Dip incline. (Gresley)

Guhr. *See* Keiselguhr.

Guhr dynamite. An explosive prepared by usually mixing three parts nitroglycerin and one part kieselguhr. Other proportions may be used. (Brunswig, p. 296)

Guía (Sp.). 1. Indications (of a vein or pay streak, or of metal in a panning test). 2. Guide for cage in shaft. (Dwight)
3. A short drill used for starting a drill hole. 4. (Colom.). A main level or gallery. 5. (Peru) A blasting fuse. 6. *G. de filón*, a leader in a lode; guide; feeder, or pay streak. 7. (Peru) The final sample of ore used as a test. (Pfordte)

Guide plate (Scot.). A cast-iron plate containing grooves or ridges to guide hutches or cars onto rails. (Barrowman)

Guide pulley. *See* Guides, 7.

Guide rope. A cage guide. (Standard)

Guides. 1. The timbers at the side of a shaft to steady and guide the cage. 2. The holes in a crossbeam through which the stems of the stamps in a stamp mill rise and fall. 3. In a rolling mill, a wedge-shaped piece held in the groove of a roll to prevent the sticking of the bar by peeling it out of the groove. When

the guide is held by a hanger or counterweight against the underside of the roll, it is called a hanging guide. (Raymond)
4. (Corn.) Cross veins in the St. Just district. 5. A boring rod having an enlargement or wings fitted to it to suit the size of the bore hole for steadying the rods when a considerable depth has been attained. (Gresley)
6. In a steam engine, a cross-head guide. 7. A pulley to lead a driving belt or rope in a new direction, or to keep it from leaving its desired direction. 8. A curved plate directing a sheet of water against the buckets of a water wheel. (Standard)

Guide tube. A tube for grinding a bit or drill. (Standard)

Guiding bed (Eng.). A thin band of coal leading to the regular seam. (Gresley)

Guija (Mex.). Gangue. Sometimes applied to quartz; a pebble. (Dwight)

Guijarro (Sp.). 1. A pebble; bowlder. 2. Any siliceous stone. (Halse)

Guijo (Mex.). A pointed pivot, upon which turns the upright centerpiece of an *arrastre*. (Dwight)

Guijola (Mex.). A double bellows used for supplying blast to copper-smelting furnaces. (Halse)

Guijoles (Mex.). Kidney-shaped pieces of cassiterite found in rhyolite. (Halse)

Guijoso. 1. (Sp.) Gravelly; full of pebbles. 2. (Mex.) Quartzose. (Halse)

Guillotine. A machine for breaking iron with a falling weight. (Raymond)

Guimet blue. An artificially prepared ultramarine. (Webster)

Guincho (Port.). A winch or drum. (Halse)

Guinea gold. Twenty-two carat gold, of which guineas were coined. (Standard)

Guingaro (Mex.). Pickaxe. *See* Huingaro. (Dwight)

Guixa (Sp.). Quartz. (Hanks)

Gulch (Cal.). A narrow mountain ravine; a small cañon. (Hanks)

Gulching (No. Staff.). The moving and cracking noise underground due to the settling of the mine roof. (Gresley)

Gulf. A large deposit of ore in a lode. (Century)

Gullet. 1. An opening in the strata. (Raymond)
2. A narrow working cutting used for a dirt-car track. (Standard)

Guillies (Corn.). Worked-out cavities in a mine. (Duryee)

Gully. 1. A small watercourse with steep sides, usually cut out of clay or earth. (Roy. Com.)
2. A metal tram rail or tram plate. (Century)

Gulph of ore. A very large deposit of ore in the lode (Whitney). A variation of gulf.

Gum. 1. (Scot.) Very small coal, for example, that which will pass through a screen having a mesh of one-fourth inch or less (Barrowman). Slack; screenings.
2. (N. Z.) *See* Kauri resin.

Gumbo. 1. A name current in Western and Southern States for those soils that yield a sticky mud when wet (Kemp). (Southwest Mo.) A putty-like clay associated with lead and zinc deposits. (Tex.) A clay encountered in drilling for oil and sulphur.
2. The stratified portion of the lower till of the Mississippi Valley. (Standard)

Gum digger (N. Z.). One whose occupation is to dig the fossil resin of the Kauri pine, which is used in the manufacture of varnish. (Webster)

Gum dynamite. Explosive gelatin. (Standard)

Gummite. An alteration product of uraninite of doubtful composition. (Dana)

Gun. A bore hole in which the charge of explosive has been fired with no other effect than to blast off a small amount of material at the mouth of the bore hole; also called a Bootleg or "John 'Odges" (Du Pont). *See* Blown-out shot.

Gunboat. A self-dumping box on wheels, used for raising (or lowering) coal in slopes; a monitor, a skip. (Chance)

Guncotton. A nitrocotton of the highest nitration or containing the greatest possible percentage of nitrogen. Sometimes called Insoluble cotton. It is used as a bursting charge for submarine mines and for demolishing bridges and other structures in warfare. (Du Pont)

Gunite. 1. A cement applied, by a cement gun, to the roof and sides of a coal mine. 2. To cement with a cement gun.

Gun metal. An alloy of copper with tin, or zinc, and sometimes a little iron. The common formula is nine parts copper to one tin; Aich's metal and some other gun metals contain zinc and iron but no tin. (Raymond)

Gunned shot (Scot.). *See* Blown-out shot.

Gunner (Kans.). A blown-out shot.

Gunnies. 1. (Corn.) In mining, breadth or width. A single gunnies is a breadth of 3 feet. (Standard) 2. (Corn.) The vacant space left where the lode has been removed (Raymond). A crevice. Also spelled Gunniss.

Gunniss (Corn.). *See* Gunnies.

Gun of wood (Derb.). A hollow plug. (Hooson)

Gunpowder. A black or brown explosive substance, consisting of an intimate mechanical mixture of saltpeter, charcoal, and sulphur, used in gunnery and blasting. It consists of 70 to 80 per cent saltpeter, and 10 to 15 per cent of each of the other ingredients. (Webster)

Gunpowder paper. Paper spread with an explosive compound. It is rolled up for use in loading. (Standard)

Gunpowder press. A press for compacting meal powder before granulating into gunpowder. (Standard)

Gunter's chain. The chain commonly used in surveying, having 100 links, each 7.92 inches long. (Standard)

Gurdy (Scot.). An arrangement of three pulleys with brake for self-acting inclines. (Barrowman)

Gurgulho (Braz.). A horizontal, bedded plateau deposit. It is made up of coarse rocks with more or less red clayey earth and frequently contains diamonds; a pudding stone. (Halse)

Gurgusco (Panama). Extracting the rich ore. (Lucas)

Gurgusero (Panama). A spoiler. (Lucas)

Gurhofite. A snow-white variety of dolomite, containing a large percentage of calcium. (Standard)

Gurlet. A mason's pickax having one cutting edge and a point. (Standard)

Gurmy. A mine level; working. (Standard)

Gurt (Corn.). A channel to carry water from an ore-dressing floor. (Davies)

Gusher. An oil well with a large natural flow. (Webster)

Guss (Bristol, Eng.). A short piece of rope by which a boy draws a tram or sled in a mine. (Gresley)

Gut. To rob, or extract, only the rich ore of a mine. (Weed)

Gutter. 1. (Forest of Dean). An airway through a goaf. 2. Candles or dips, when subjected to the warm air of a mine, waste away very rapidly, and are said to gutter. (Gresley)
3. The dry bed of a river of Tertiary age, containing alluvial gold, often covered to a great depth by volcanic matter or débris; also called Bottom. 4. A channel for running water. (Webster)
5. (Aust.) The lowest portion of an alluvial gold deposit. (Skinner)

Guttering. 1. A channel cut along the side of a mine shaft to conduct the water back into a lodge or sump. (Gresley)
2. A process of quarrying stone in which channels, several inches wide, are cut by hand tools, and the stone block detached from the bed by pinch bars. (Greenwell, p. 151)

Gutter-up (Mid.). A roof fall which extends to an excessive height. *See also* Cut-up. (Gresley)

Gutzkow's process. A modification of the sulphuric-acid parting process for bullion containing large amounts of copper. A large excess of acid is used; the silver sulphate is then reduced with charcoal, or, in the original process, ferrous sulphate. (Liddell)

Guy. A guide; a rope, chain, or rod attached to anything to steady it; a rope which holds in place the end of a boom, or spar; a rod or rope attached to the top of a derrick and extending obliquely to the ground where it is fastened. (Webster)

Guy anchor. The support to which derrick guys are attached. (Bowles)

Guy rope. *See* Guy.

Guy rings. Rings on the head block of a derrick mast, to which the guy ropes are attached. (Standard)

Gwag (Corn.). Rubbish; an old mine working. (Webster)

Gweeon (Aust.). An aboriginal stone hatchet. (Webster)

Gwythyen (So. Wales). A mineral vein or seam. (Gresley)

Gymnite. A synonym for Deweylite. (Chester)

Gypseous; Gypsiferious. Resembling, containing, or consisting of gypsum. (Webster)

Gypsite. *See* Gypsum.

Gypsum. Hydrous calcium sulphate, $CaSO_4+2H_2O$. Contains 32.5 per cent lime, 46.6 per cent sulphur trioxide, and 20.9 per cent water. *Alabaster* is a fine-grained compact variety, white, shaded, or tinted. *Gypsite* is an incoherent mass of very small gypsum crystals or particles, and has a soft, earthy appearance; contains various impurities, generally silica and clay. *Satin spar* is a fine fibrous variety which has a pearly, opalescent appearance. *Selenite* is a variety which occurs in distinct crystals or in broad folia. Some crystals are 3 or 4 feet long and clear throughout. (U. S. Geol. Surv.)

Gypsum wedge. A thin wedge-shaped piece of selenite. (A. F. Rogers)

Gyratory breaker; Gyratory crusher. A rock crusher built on the principle of the old fashioned coffee mill. It consists of a vertical spindle the foot of which is mounted in an eccentric bearing within a conical shell. The top carries a conical crushing head revolving eccentrically in a conical maw. There are three types of gyratory; those which have the greatest movement on the smallest lump; those that have equal movement for all lumps; those that have greatest movement on the largest lump. (Liddell)

H.

Haas furnace. A muffle furnace of the McDougall type, the hearths being separated by suitable flues through which the products of combustion from the fireplace are made to pass. (Ingalls, p. 142)

Haas tester. An instrument for obtaining the flashing point of petroleum. (Mitzakis)

Haba (Sp.). A piece of ore more or less rounded and encased in gangue. (Halse)

Habilitador (Sp.). One who supplies money for working a mine. (Min. Jour.)

Habilitador (Peru). A money lender. (Lucas)

Habilitar (Peru). To furnish working funds for a mine or mill. (Dwight)

Habit. In crystallography, the characteristic form, as determined by the faces developed and their shapes and relative proportions, of the crystals of a given mineral from the same general region or geologic association (La Forge). In the crystals of a given species there is constancy of angle between like faces, but the forms of the crystals may be many. As the relative size of a crystal changes, the *habit* may vary indefinitely. *See* Form. (Dana)

Hacer (Sp.). *H. adelantos*, to advance money; *H. mina*, to make a mine. (Halse)

Hacha (Sp.). Ax or hatchet. (Halse)

Hachazuela (Mex.). Adze. (Dwight)

Hachero (Sp.). A wood cutter. (Halse)

Hachita (Mex.). Hatchet. (Dwight)

Hachure. A short line used in drawing and engraving, especially in shading and denoting different surfaces as in map drawing to represent slopes of the ground. (Webster)

Hacienda (Sp.). 1. Exchequer; treasury; public revenue; capital; funds; wealth; landed estate; establishment. 2. In mining it is usually applied to the offices, principal buildings, and work for reducing the ores (Raymond); *H. de beneficio*, metallurgical works; *H. de fundición*, smelting works; *H. de maquila*, a custom mill. (Dwight)

Haciendero (Sp.). The superintendent of the hacienda. (Min. Jour.)

Hack. 1. (No. of Eng.) A pick or tool with which colliers cut or mine the coal. (Gresley)
2. A sharp blade on a long handle used for cutting billets in two. (Raymond)
3. To pile up edgewise for the purpose of drying, as green molded bricks. 4. A set of bars in a tail race. 5. A place where bricks are set to dry; also, a pile of green bricks. (Standard)

Hackbarrow. A barrow for taking bricks from the molders to the hacks. (Webster)

Hack hammer. A hammer resembling an adz, used in dressing stone. (Webster)

Hacking. 1. The operation of picking a grindstone or an abrading wheel to remove the glaze. 2. The use of two thin masonry courses instead of one as thick as both of them. 3. In gem cutting, a series of cuts in a metal lap to serve as receptacles for the abrasive powder. 4. The stacking of bricks for drying. (Standard)

Hacking board. A board on which to pile unburned dried bricks. (Standard)

Hack iron. A miner's pick ax or hack. A chisel or similar tool for cutting metal, as wire, into nails. (Webster)

Hackly. Showing jagged points in fracture (Standard). A term applied to the fracture of metals.

Hacksaw. A fine toothed saw having a narrow blade stretched in a frame, for cutting metal. (Webster)

Hade. 1. The angle of inclination of a vein measured from the vertical; dip is measured from the horizontal. *See* Underlay, 2. (Skinner)
2. To deviate from the vertical; said of a vein, fault, or lode. (Webster)

Haenisch and Schroeder process. A method for the recovery of sulphur as liquid sulphurous anhydride from furnace gases. (Ingalls, p. 166)

Hag. 1. (Scot.) A cut; a notch. 2. To cut as with an ax; to cut down the coal with the pick. (Barrowman)
3. (No. of Eng.) A quagmire or pit in mossy ground; any broken ground in a bog. (Century)

Hähner furnace. A continuously-working shaft furnace for roasting quicksilver ores. The fuel is charcoal, charged in alternate layers with the ore. The Vall' Alta furnace is a modification, having the iron tubes of the Alberti. (Raymond)

Haiarn (Wales). Iron. (C. and M. M. P.)

Haimanta. One of a series of beds of great thickness and varying lithological character, overlying the crystalline schists, and underlying the Lower Silurian, in the Himalaya mountains. (Standard)

Hair plate. *See* Bloomery.

Hair pyrites. Same as Millerite. (Standard)

Hair salt. Epsomite when in silky fibers. A form of alunogen. (Webster)

Hair stone. Quartz thickly penetrated with hairlike crystals of rutile, actinolite, or some other mineral. (Webster)

Hair zeolite. A synonym for fibrous zeolite, which may be natrolite, scolecite, or mesolite. (Chester)

Hake. A shed where tiles are dried. (Standard) *See* Hack, 5.

Half-and-half. Solder made of equal parts of tin and lead. (Webster)

Half-and-half plane, or Half-end half-plane (Scot.). In a direction midway between plane course and end course (Barrowman). *See also* Half-course.

Half balk (Eng.). A mine prop cut into halves. *See also* Balk, 2. (G. C. Greenwell)

Half blinded (Scot.). Two ends driven off a plane, one on each side and not opposite each other by half their width. (Barrowman)

Half-bloom. A round mass of puddled iron before squeezing; a half-made bloom. (Standard)

Half-brilliant. A single-cut brilliant. (Standard)

Half-course. A drift or opening driven at an angle of about 45° to the strike and in the plane of the seam.

Half-edge seams (Scot.). Highly inclined seams; seams lying at an inclination of 1 in 1. (Barrowman)

Half-end (York.). *See* Horn coal, 1.

Half facet. In gem cutting, a skill-facet or cross-facet on a brilliant. (Standard)

Half-marrow (Newc.). Young boys, of whom two do the work of one loader. (Raymond)

Half mask. The part of a mine rescue, or oxygen-breathing apparatus which covers the nose and mouth only, and through which the wearer breathes the oxygen furnished by the apparatus.

Half-moon (Eng.). A scaffold nearly filling up one-half the sectional area of a shaft. (Gresley)

Half-pitch. Dipping or rising 18 inches to the yard. (Roy)

Half set. In mine timbering one leg piece and a collar. (Steel)

Half-turn socket. In oil-well drilling, a fishing tool having jaws bent around in an incomplete circle, to engage lost tools that lean to one side of the well. (Nat. Tube Co.)

Half work; Half wark (Eng.). When the day's work is half over, or when by reason of poor trade conditions, half-time is worked. (G. C. Greenwell)

Halite; Rock salt. Natural sodium chloride, NaCl. *See* Salt, 1. (U. S. Geol. Surv.)

Hallazgo (Sp.). Discovery of an ore deposit. (Halse)

Hälleflinta (Sweden). A dense, compact, metamorphic rock, consisting of microscopic quartz and feldspar crystals, with occasional phenocrysts and sometimes hornblende, chlorite, magnetite and hematite. It is associated with gneisses, but is of obscure origin. (Kemp)

Hällenflintoid. Of or resembling hälleflinte. (Century)

Hallett table. A table of the Wilfley type, except that the tops of the riffles are in the same plane as the cleaning planes and the riffles are sloped toward the wash-water side. (Liddell)

Hall furnace. A modification of the Wethey furnace for roasting sulphide ore. (Ingalls, p. 97)

Hallite. A yellow to green variety of mica, $H_{24}Mg_{12}(Al.Fe)_4Si_9O_{48}$, that crystallizes in the monoclinic system. (Standard)

Halloysite. A claylike, aluminum silicate, resembling kaolinite but amorphous and containing a larger but uncertain quantity of water, $2H_2O.Al_2O_3.2SiO_2+Aq$. (U. S. Geol. Surv.)

Hologen. In chemistry, any one of the elements bromine, chlorine, fluorine, and iodine (The radical cyanogen is also included by some chemists), which with the metals form compounds analogous in some respects to common salt. (La Forge)

Haloid. 1. In chemistry, of, pertaining to, containing, or resembling sea salt, sodium chloride. 2. Pertaining to, containing, or derived from one of the halogens. 3. A compound of one of the halogens with a metal: in this sense more properly spelled Halid or Halide. (La Forge)

Haloidite. Wadsworth's name for rock salt. (Kemp)

Halotrichite. Hydrous sulphate of iron and aluminum, $FeSO_4Al_2(SO_4)_3+24H_2O$, occurring in yellowish, silky fibrous forms. (Dana)

Haloxylin. A mixture of yellow prussiate of potash, niter, and charcoal, used as an explosive. (Century)

Halter (New Zealand). A miner working on his own account. (Anderson)

Halvanner (Corn.). A dresser of impure or inferior ore. (Davies)

Halvan ore. *See* Halvans.

Halvans; Halvings; Hanaways (Corn.). Ores much mixed with impurities. (Raymond)

Hambergite. A beryllium borate, $Be_3(OH)BO_3$, occuring in grayish-white, prismatic crystals. From Langesund fiord, southern Norway. (Dana)

Hamlinite. A basic phosphate of aluminum and strontium. In colorless rhombohedral crystals. Occurs with herderite, bertrandite, etc., at Stoneham, Me. (Standard)

Hammer. To make a noise as of blows in a pipe, the result of sudden stoppage of the flow, or of turning on steam; said of water. (Standard)

Hammer-and-plate. A signaling apparatus (Chance). A gong.

Hammer beam. A short beam projecting laterally from the inside of a wall, and serving as a tie beam. (Standard)

Hammer-dress. To dress or face stone with a hammer. (Webster)

Hammer-harden. To harden, as a metal, by hammering it while cold. (Webster)

Hammerman. 1. One who uses a hammer constantly in any metal-working trade. (Standard) 2. One who strikes with a hammer in hand drilling of holes for blasting.

Hammerpick. *See* Pollpick.

Hammer-refined. Designating steel the grain of which has been made finer and closer by heavy hammering followed by lighter and quicker blows at the finish. (Webster)

Hammer scale. Scale formed on hammering heated metal. (Webster)

Hammer slag. Anvil dross. (Webster)

Hammersmith. One who shapes or works metal with a hammer. (Standard)

Hammer tongs. Blacksmith's tongs having projecting lugs for engaging the holes of hammer heads or the like during forging. (Webster)

Hammer-wrought. Wrought with a hammer; said of ornamental ironwork. (Standard)

Hammochrysos. A mineral known to the ancients and characterized by gold-like spots. Probably a sand from yellowish mica schist. (Webster)

Hancock jig. A jig with movable sieve having both an up-and-down and a reciprocating motion. (Liddell)

Hand, or Handle (Eng.). To work a winding, pumping, hauling, or other engine. (Gresley)

Hand barrow. 1. A frame or flat barrow, without a wheel, carried by handles. 2. A kind of hand cart. (Webster)
3. A wheelbarrow. (Standard)

Handbrace. A tool used in boring by hand. (Standard)

Hand dog (Eng.). A kind of spanner or wrench for screwing up, or disconnecting, the joints of boring rods at the surface. (Gresley)

Hand-dug wells. The earliest known method of extracting petroleum was by means of pits dug by hand labor. The usual method was to dig a few feet and then allow the oil to collect at the bottom, whence it was subsequently collected by means of a suitable vessel. The deepest of these wells rarely exceeded 50 feet. (Mitzakis)

Handfarht (Ger.). The descent into a mine by ladders. (Davies)

Hand-fill (Eng.). To separate the small from the large coal in the mine, the latter being filled by the hand into the car, and the former thrown to the side of the working place, or filled separately as required. (G. C. Greenwell)

Hand-filled coal (Scot.). Lump coal which the miner loads by hand. (Barrowman)

Hand frame. An iron barrow used in a foundry. (Standard)

Handful (Brist. and Som.). A length of 4 inches. (Gresley)

Hand gear. 1. (Eng.) A small hand-cylinder for winding or hoisting from shallow work (Bainbridge). A windlass.
2. The mechanism for opening the valves of a steam engine by hand in starting. (Standard)

Hand hammer. Any hammer wielded by hand. A blacksmith's (or miner's) hammer used with one hand as distinguished from a heavier hammer or sledge. (Webster)

Handhole. A hole, as in a boiler, into which the hand may be inserted. (Standard)

Hand hook. An implement for twisting iron bars. (Standard)

Hand level. A small instrument consisting of a telescope with a bubble tube so attached that the position of the bubble can be seen when looking through the telescope. (Webster)

Handling (Mid.). Reloading coal underground from one car to another. (Gresley)

Hand-picked coal. Coal from which all stones and inferior coal have been picked out by hand; large lumps. (Barrowman)

Hand screw. A jackscrew. (Standard)

Hand specimen. A piece of rock trimmed to a size, usually 1 by 3 by 4 inches, for megascopic study and for preservation in a working collection. (La Forge)

Handspike. 1. A wooden lever for working a capstan or windlass. (C. and M. M. P.)
2. A bar used as a lever in lifting weights or overcoming resistance; a heaver. (Standard)

Hand whip. A counterpoised sweep for raising water from shallow pits. A shadoof. (Webster)

Handyman. At small plants, a Jack-of-all-trades, as a rigger, millwright, and machinist combined (Willcox). A man employed to do various kinds of work.

Hang. 1. (Brist.) The hade of a fault. (Gresley)
2. To have its charge choked up or arched in one part, while the part underneath falls away so as to leave a gap; said of a blast furnace. (Webster)

Hang-bench (Eng.). A support for a windlass. (Bainbridge)

Hanger. 1. (Scot.) The hook of a miner's lamp. (Barrowman)
2. (Corn.) The hanging wall. (Duryee)
3. That which hangs, overhangs, or is suspended. (Webster)
4. *See* Hanging bolts.
5. A frame containing a bearing for a shafting. (Standard)

Hanger-on (Eng.). The man who runs the full trams upon the cages and gives the signals to hoist (Gresley). *See also* Cager, 1.

Hangfire. Said of a charge that explodes later than expected. A hangfire rarely occurs with electric firing, but it is not infrequent with blasting cap and fuse. (Du Pont)

Hanging. 1. The hanging wall; the rock on the upper side of a mineral vein or deposit (Weed). *See* Hanger, 2.
2. Sticking or wedging of part of the charge in a blast furnace (Willcox). *See* Hang, 2.

Hanging bolts. Rods made of 1⅛ or 1¼ inch round iron, by which the wall plates are suspended while being placed in position in the shaft. Sometimes called Hangers.

Hanging coal. A portion of the coal seam which, by under cutting, has had its natural support removed. (Raymond)

Hanging deal (Aust.). Planks used to suspend a lower curb from the one above it, in cases where backing deals are necessary. (Power)

Hanging glacier. A glacier of small size on so steep a slope that the ice breaks off and falls from its lower end. (Century)

Hanging guide. *See* Guides, 3.

Hanging its water (Scot.). The bucket failing to pump on account of a faulty valve, or air between the bucket and the valve, the column of water above the bucket being sufficient to prevent the opening of the bucket lids, is said to hang its water. (Barrowman)

Hanging-on (Eng.). The pit bottom, level, or inset, at which the cages are loaded. (Gresley)

Hanging scaffold (Scot.). A movable platform in a shaft attached to a winding rope. (Barrowman)

Hanging sets (Scot.). Timbers from which cribs are suspended in working through soft strata. (Barrowman)

Hanging side; Hanging wall; Hanger. The wall or side above the ore body. (Winchell)

Hanging spear-rods (Eng.). Adjustable wooden pump rods, by which a sinking pump is suspended in a shaft. (Gresley)

Hanging tie. A tie, as in a floor, the end of which is upheld by a strap, connecting it with a beam above. (Standard)

Hanging valley. A valley the floor of which is notably higher than the level of the valley or shore to which it leads.

Hanging valve. 1. A rotary-engine valve which is hinged and falls by gravity so as to form an abutment, but is lifted by the passing piston. 2. A clack valve or flap valve. (Standard)

Hanging wall. The upper wall of an inclined vein, or that which hangs over the miner at work. (Webster)

Hangklip (So. Afr.). An overhanging cliff. (Standard)

Hanksite. A mineral having the following composition, $9Na_2SO_4,2Na_2CO_3,KCl$, occurring in hexagonal prisms, short prismatic to tabular; also in quartzoids. Color, white to yellow. From California. (Dana)

Hapire (Peru). A trammer; a laborer who assists a miner, and who carries ore on his back or shoulders. In Peru the load is 50 to 75 pounds, while in Chile as much as 200 pounds are carried in a leather bag at one time. (Halse)

Haplite. A name proposed by L. Fletcher for that variety of granite which consists of quartz and potash feldspar. The name is derived from the Greek for simple. *Compare* Binary granite. (Kemp)

Harbor. In glass making, a large chest for holding materials before fusion. (Standard)

Hard. 1. Containing certain mineral salts in solution, especially calcium carbonate; said of water having more than eight or ten grains of such matter to the gallon. 2. In ceramics, requiring great heat: said of muffle-colors in porcelain decoration. (Standard)

Hard coal. Same as Anthracite.

Hard drawn. Drawn while cold; said of wire. (Standard)

Hardened steel. Steel that has been hardened by quenching from or above the hardening temperature. (Hibbard)

Hardening-kiln. A kiln in which, in the transfer printing process, unfinished pottery is exposed to a low heat to drive away superfluous oil. (Century)

Hard head. 1. A residual alloy, containing much iron, arsenic and tin, produced in the refining of tin. (Raymond)
2. A hard knob or knot formed by extreme cementation of sandstone in certain spots. (Bowles)
3. A large, smooth, rounded stone found especially in coarse gravel (Century). A nigger head.

Hard heading (Eng.). A heading, tunnel, or drift driven in stone. (Gresley)

Hardinge mill. A tube mill made with two conical sections connected by a central very short cylinder. The cone at the feed end is very short so that the large pebbles settle and grind at the large end where the feed is coarse. (Liddell)

Hard lead. Lead containing certain impurities, principally antimony. (Raymond)

Hard metal. An alloy of about two parts copper with one of tin, prepared in the process of making gun metal. (Century)

Hardness. The cohesion of the particles on the surface of a body (as a mineral) as determined by its capacity to scratch another, or be itself scratched. (Webster) The hardness of a mineral is relatively constant. For convenience, all minerals are referred to a scale of hardness of ten units composed of common or well known minerals (*see* Hardness scale). The degree of hardness is expressed by the number of the mineral in the scale, and minerals of intermediate hardness are expressed by fractions. (Buckley)

Hardness scale. The scale by which the hardness of a mineral is determined as compared with a standard. The Mohs scale is as follows: 1. Talc; 2. Gypsum; 3. Calcite; 4. Fluorite; 5. Apatite; 6. Orthoclase; 7. Quartz; 8. Topaz; 9. Sapphire; 10. Diamond. (Dana)

Hard pale solder. An alloy of tin 2 parts, lead 1 part: for pewterers' use. (Standard)

Hardpan. A name specially developed in the digging of auriferous placers, and applied to the layers of gravel which are usually present a few feet below the surface and which are cemented by limonite or some similar bond. They are therefore resistant. It is also used to describe bowlder clay, which is likewise difficult to excavate. (Kemp)

Hard porcelain. Porcelain characterized by a body of kaolin and feldspar with a feldspathic glaze, as Chinese, Sèvres, Berlin, etc., porcelain. (Standard)

Hard pottery. Pottery which can not be scratched by a sharp-pointed piece of iron. (Standard)

Hard-rock phosphate. A term used in Florida to designate a hard, massive, close-textured, homogenous, light-gray phosphate, showing larger or smaller irregular cavities, that are usually lined with secondary mammilliary incrustations of phosphate of lime. (Power)

Hards (Mid.). A hard and close-grained coal. (Gresley)

Hard solder. Any solder that melts only at a red heat: used in soldering silver, etc. (Standard)

Hard spar. A name applied both to corundum and andalusite. (Chester)

Hard steel. Steel containing more than 0.30 per cent of carbon. Employed for rubbing surfaces and where great ultimate strength is required (Webster). *See also* Steel.

Hard way, or Head grain. A plane at right angles to both rift and run, along which the rock splits with greater difficulty than in directions of either rift or run (Bowles). Sometimes called Cut-off.

Hard white ore. Georgia bauxite containing less than 1 per cent ferric oxide. (Ore Dep., p. 406)

Hardy. A square-shanked chisel or fuller for insertion in a hardy hole. (Standard)

Hardy hole. A hole in a blacksmith's anvil for the insertion of a calking tool or other piece. (Standard)

Haricot. Red copper oxide (CuO) used as a back ground in ceramic decoration (Standard). Also spelled Harrico.

Harina (Sp.). 1. Flour; *H. fósil*, infusorial earth. 2. Fine powder of metals; *H. del bocarte*, pulp at gold-extraction mills. (Halse)

Harlequin. The Oriental opal. (Standard)

Harneado (Chile). Screening, as of ore; *Harneadoras de carbón*, a coal-screening apparatus. (Halse)

Harnear (Sp.). To screen, as in ore dressing. (Halse)

Harnerero (Mex.). The operator of a hand-jig. (Dwight)

Harnero (Mex.). Hand-jig (Dwight) A sieve; a screen. (Halse)

Harp. 1. (Scot.). A sparred shovel used in the east of Scotland for filling coal. (Barrowman)
2. (Scot.) To fill a hutch with coal at the face. (Gresley)

Harrie; Herrie (Scot.). To rob; to take all the coal that can conveniently be mined without attempting to systematically remove the whole (Barrowman). A variation of Harry, to strip; despoil; to rob.

Harrisite. A variety of chalcocite that is pseudomorphous after galena. (Standard)

Harrow (Aust.). An apparatus used for mixing gold-bearing clays. (Skinner)

Harstigite. An acid orthosilicate of manganese and calcium. The mineral occurs in small, colorless, prismatic crystals. From Sweden. (Dana)

Hartine. A white resin separated by ethyl ether from a resin from the brown coal of Oberhart. *See also* Xyloretinite. (Bacon)

Hartite. A mineral closely resembling fictelite; it melts at 75° C., and occurs near Gloggnitz, Austria, and in Styria and Carinthia. (Bacon)

Harvard brick. A term originally applied to clear, red, common brick, which were overburned, and especially so on one end or side, so that these harder burned parts were bluish black. The name is more loosely used nowadays. (Ries)

Harveyize. To subject the face of a steel plate to a process of cementation which increases the carbon in that portion of the plate, producing a plate with a comparatively soft body and a very hard face. (Century)

Harvey process. A process for carburizing the face of a piece of low-carbon steel by subjecting it to the action of carbon at a very high heat, and then a sudden chilling, as by a spray of cold water. (Webster)

Harz, or plain eccentric jig. A jig in which pulsion is given intermittently with suction. The periods devoted to them are about equal. (Liddell)

Harzburgite. A variety of peridotite that consists essentially of olivine and enstatite or bronzite. Saxonite was earlier proposed by Wadsworth (1884) for the same rock, and has priority. (Kemp)

Hasenclever furnace. 1. A vertical shaft furnace for calcining sulphide ore. (Peters, p. 172)
2. A simple, efficient muffle furnace for roasting zinc ores in Upper Silesia. (Ingalls, p. 131)

Hasenclever-Helbig furnace. A roasting furnace having a hearth inclined at an angle of 43°. The ore descends over the hearth by gravity. (Ingalls, p. 136)

Haspel (Sp. Am.). A hand winch. (Lucas)

Hassing. *See* Hasson.

Hasson; Hassing (Scot.). A vertical gutter between water rings in a shaft (Barrowman). *See also* Gauton.

Hasson deal (Scot.). A cover for a hasson. (Barrowman)

Hastial (Sp.). 1. The surface of either wall, or roof, or floor of a deposit; side of a deposit. 2. The side of a gallery, shaft, or any excavation. (Halse)

Hatajo (Mex.). A drove of pack-mules. (Dwight)

Hatch. 1. (Brist.) A door, or gate.
2. A stroke or line used in engraving or drawing to give the effect of shading. (Webster)

Hatchet stake. A small anvil on which to bend sheet metal. (Standard)

Hatchettine. A synonym for Hatchettite. (Bacon)

Hatchettite. A yellowish-white, wax-yellow or greenish-yellow hydrocarbon which darkens on exposure; it melts at 46° C., is sparingly soluble in boiling alcohol and cold ether, and is decomposed by concentrated sulphuric acid. Its specific gravity varies from 0.892 to 0.983. (Bacon)

Hatchettolite. A tantalo-niobate of uranium, near pyrochlore. In octahedrons. Color yellowish brown. Occurs with samarskite, at the mica mines of Mitchell County, North Carolina. (Dana)

Hatching (Brist.). An underground way or self-acting inclined plane, in a thin seam of coal, extending from 60 to 80 yards to the rise. (Gresley)

Hatherlite. A name proposed by A. Henderson for a syenite from South Africa which has for its feldspar anorthoclase instead of orthoclase. Pflandite is a porphyritic phase of the same. (Kemp)

Hat rollers (Eng.). Cast iron or steel rollers, shaped like a hat, revolving upon a vertical pin, for guiding haulage ropes around curves. (Gresley)

Hatter (Aust.). A miner or other worker who works alone, and therefore whose "hat covers his family." (Webster)

Hatting (Aust.). The labor of a miner who works alone. (Standard)

Haud off; Hold off (Scot.). Keep back. Called by a laborer pushing a full car to another meeting him with an empty one, the latter being obliged to get out of the way. (G. C. Greenwell)

Hauerite. Manganese disulphide, MnS_2. In octahedral of pyritohedral crystals; also massive. Color reddish-brown or brownish-black. (Dana)

Haul. 1. To transport by pulling or drawing, as cars. 2. The distance over which anything is hauled as, a long or a short *haul*. (Standard)

Haulage. The act or labor of hauling or drawing. In mining, the drawing or conveying, in cars or otherwise, of the produce of the mine from the place where it is mined to the place where it is to be hoisted, treated, used, or stored.

Haulage clip (Eng.). Levers, jaws, wedges, etc., by which trams, singly or in trains, are connected to the haulage ropes. (Gresley)

Haulage plant. A mechanical installation for the tramming of rock (ore or coal), operated by ropes, compressed air, or electricity. (Weed)

Haulageway. The gangway, entry, or tunnel through which loaded or empty mine cars are hauled by animal or mechanical power.

Hauler. Same as Driver.

Haulier (Fr.). A boy or man who goes with a pony or horse in the mine, or who attends the trips upon engine planes, etc. (Gresley). A driver.

Haunch. The part of an arch from the keystone to the skew back. (C. and M. M. P.)

Haupt furnace. A gas-fired Silesian furnace with recuperative chambers for preheating the air for secondary combustion. (Ingalls, p. 409)

Haurl (Scot.). A claut; a scraper. (Barrowman)

Hausmannite. A mineral, Mn_3O_4 or $MnO.Mn_2O_3$. In tetragonal octahedrons and twins; also granular massive, particles strongly coherent. Luster submetallic. Color brownish black. (Dana)

Haüynite; Haüyne. A silicate and sulphate of sodium, calcium, and aluminum. $Na_2Ca(NaSO_4.Al)Al_2(SiO_4)_3$. (Dana)

The name of the mineral is often prefixed to the names of those rocks that contain it. (Kemp)

Hauzeur furnace. A double furnace for the distillation of zinc wherein waste heat from one set of retorts is utilized for heating the second set. (Ingalls, p. 443)

Hawk's eye. A blue variety of crocidolite from South Africa (Power). *See also* Tiger-eye, 1.

Hawser. 1. Any wire rope used for towing on lake or sea. A fiber hawser consists of three strands laid up right-handed. (C. M. P.)

2. A large rope, 5 to 10 inches in circumference, generally of 9 strands and left-handed twist. (Standard)

Hawser-laid rope. A rope having three strands of yarn twisted left-handed, the yarns being laid up right-handed. Synonymous with cable-laid rope as applied to wire ropes. (C. M. P.)

Hawser wire rope. Galvanized rope of iron or steel, usually composed of 6 strands, 12 wires each, principally used in marine work for towing purposes. (C. M. P.)

Hayden process. An electrolytic process for copper refining. There is but one true cathode and one anode in the tank, a large number of plates of unrefined copper being placed between and parallel to them. The side of each plate toward the cathode then acts as an anode, while copper is deposited on the side of each plate toward the anode, until the entire plate has moved over by the amount of its own thickness. This is the so-called series method of refining. (Liddell)

Hazle (No. of Eng.). In coal mining, a tough mixture of sandstone and shale (Gresley). Also spelled Hazel.

Head. 1. Any road, level, or other subterraneous passage driven or formed in the solid coal, etc., for the purpose of proving and working the mine. 2. That part of a face nearest to the roof. 3. (Som.) Any length of working faces. 4. (So. Staff.) A shift or day's work by the stint in heading-out, or driving of deadwork. 5. The top end of the boring rods above the surface. 6. Pressure of water in pounds per square inch, or, of so many feet. 7. To cut or otherwise form a narrow passage or head. 8. A lift. 9. *See* Motive column. (Gresley)
10. In the plural, the purest ore obtained by washing; distinguished from middling, tailing, and slime, that are also used in the plural form. 11. The circular plate that forms the end of a cylinder of a steam engine. (Crofutt)
12. *See* Sluice head. 13. The attitude or direction of the set of parallel planes in a massive crystalline rock along which fracture is most difficult. It is normal to the direction of the strongest cohesion. 14. A rammer for crushing gold quartz. 15. (Eng.) An earthy deposit from rock decay. (Webster)
16. A layer of angular débris of adjacent strata, which generally overlies the raised beaches of England. (Standard)

Head-bay. The water space immediately above the lock in a canal. (Century)

Headblock. 1. A stop at the head of a slope or shaft to stop cars from going down the shaft or slope. 2. A cap piece. (Steel)

Headboard. A wedge of wood placed against the hanging wall, and against which one end of the stull is jammed. (C. and M. M. P.)

Head coal (Scot.). Formerly, the stratum of a coal next the roof. More usually now, the top portion of a coal seam when left unworked, either permanently or to be afterwards taken down; the top coal on a loaded wagon. (Barrowman)

Header. 1. A rock that heads off or delays progress. 2. A blast hole at or above the head. 3. A stone or brick laid lengthwise at right angles to the face of the masonry. 4. An entry-boring machine that bores the entire section of the entry in one operation. (Reis)
5. (Mid.). A collier or coal cutter who drives a heading. (Gresley)
6. A plank or timber, longer than a cap, supported by two props, one at each end. (Big Branch Coal Co. *v.* Wrenchie, 170 S. W. Rept., p. 16)

Headframe. A structure erected over a shaft to carry the sheaves over which the cable runs for hoisting the cage. Called in England, Gallows frame. (Chance)

Head gate. A water gate or floodgate of any race or sluice. (Standard)

Headgear. 1. That portion of the winding machinery attached to the headframe, or the headframe and its auxiliary machinery. (Chance)
2. That part of deep-boring apparatus which remains at the surface. (Raymond)

Head grain. Same as Hard way. (Bowles)

Head house. The house or building that encloses the headframe. *See also* Gallows frame. (Chance)

Heading. 1. The vein above a drift. *See* Back. 1. 2. An interior level or airway driven in a mine. 3. In longwall workings, a narrow passage driven upward from a gangway in starting a working in order to give a loose end. (Raymond)
4. A continuous passage between two rooms, breasts, or other working places. 5. (Ark.). The narrow part of an entry near the working face. (Steel)
6. The operation of driving a head.
7. (Scot.). The top portion of the load above the tub (car) sides. (Gresley)
8. A collection of close joints. (Perkins)
9. A term sometimes applied to the preliminary drift or pioneer bench in tunnel driving. (Bowles)

Heading-and-stall. *See* Room-and-pillar method.

Heading driver; Entryman. A miner who drives a heading, entry, drift, or adit.

Headings. 1. In ore dressing, the heavier portions collecting at the upper end of a buddle or sluice, as opposed to the tailings, which escape at the other end, and the middlings, which receive further treatment (Raymond). Also called Concentrates. *See* Head, 10.
2. Coarse gravel or drift overlying placer deposits. 3. That portion of a vein which is above a level. (Power)

Heading seam. *See* Joint, 3.

Heading side. The underside of a lode (Davies). *See* Heading wall.

Heading tool. A tool for swaging bolt heads. (Standard)

Heading wall. The foot wall or lower wall of a lode along which the heading is run. (Skinner)

Headline. A line extending from the front of a dredge to an anchorage and used to hold the dredge in place during operations. *See also* Side line, 1. (Weatherbe)

Headpiece. A cap; a collar. (Chance)

Headrace. The channel by which water is led to a water wheel, or to any machinery. (Standard)

Headroom. Height as between the floor and the roof, as in a mine. (Gresley)

Heads. 1. (N. Y. and Pa.). A local term applied by bluestone quarrymen to the open joints that run north and south. (Bowles)
2. (Eng.). *See* Headings, 1. *Also* Head, 10.
3. (Scot.). Large top-coal on a loaded hutch. (Barrowman)
4. (Aust.). Small faults. (Power)

Head side (No. Staff.). The rise side of a heading driven on the strike. (Gresley.)

Headsman (No. of Eng.). In a colliery, one who brings coal from the workings to the tramway. (Webster)

Head stocks. Gallows frame; headframe. (Chance)

Headsword (Corn.). Water discharged through the adit level. (Davies)

Head tin (Corn.). *See* Headings, 1.

Headtree (Newc.). A piece of wood, on top of a prop, to support the roof. (Min. Jour.)

Headwater erosion. The extension of a stream valley by erosion of the upland at its head. (Webster)

Headway (Newc.). 1. *See* Crosshead-ing. The headways are the second set of excavations in post-and-stall work. (Raymond)
2. (No. of Eng.). The direction of the cleat or a place driven parallel with the cleat, that is, end-on. (Gresley)

Headwork. 1. The headframe with the head gear. (Webster)
2. (Ark.) The cutting and other work done at the face of an entry. (Steel)

Healing stone. A slate or tile for roofing. (Standard)

Heap. 1. (Newc.) The refuse at the pit's mouth. (Raymond)
2. (Scot.) To load up a tub (car) above the top of the sides. (Gresley)

Heap keeper (No. of Eng.). A man who looks after the sorting and cleaning of the coal at the surface, and keeps things in order about the shaft.

Heap matte. Matte produced by heap roasting.

Heap roasting. Burning the sulphur out of ores piled in heaps, with a small amount of wood or other fuel. (Weed)

Heapstead (Eng.). The entire surface works about a colliery shaft. (Gresley)

Hearth. 1. The floor or sole of a reverberatory. 2. The crucible of a blast furnace. (Raymond)
3. A bloomery. 4. A plate or table upon which cylinder glass is flattened. (Standard)

Hearth accretions. *See* Sow, 4.

Hearth bottom. A furnace bottom soaked to some depth with metal. (Hofman, p. 85)

Hearth cinder. Slag produced in refining metals. (Webster)

Hearth ends. Particles of unreduced lead ore expelled by the blast from a furnace. (Raymond)

Hearth plate. A cast-iron plate serving as a sole for a refiner's furnace. (Standard)

Heart joint (Scot.). A particular form of attachment joint between the bucket-rod and the foot-rod of a pump. (Barrowman)

Heart shake. A defective condition of timber shown by cracks extending from the heart outward. (Standard)

Heart wall. A wall hearted with rubble, concrete, or other filling. (Webster)

Heat. 1. A physical agent or form of energy generated by the transformation of some other form of energy, as by combustion, chemical action, or the stoppage of mass-motion by friction, possessing the power of expanding, melting, vaporizing, and decomposing bodies, of raising their temperature, and of passing through space with the velocity of light. 2. The material heated, melted, etc., at one time; as, the foundry runs three *heats* a day. (Standard)
3. One operation in a heating furnace, Bessemer converter, puddling furnace, or other furnace not operating continuously. (Raymond)
4. (Eng.) The elevated temperature produced by spontaneous combustion in a mine. (Gresley)

Heat economizer. A device by which the steam in a steam engine or the hot air of an engine is cooled, causing it to impart its heat to a metallic body which stores up the heat and imparts it in turn to the next charge of steam or air, thus reducing the waste of heat; a regenerator. (Century)

Heat energy. That form of energy which manifests itself through thermal effects. (Webster)

Heat engine. An engine which transforms heat into mechanical work. (Century)

Heater. One of the workmen who assists in the operation of rolling large steel armor plates. (Standard)

Heathen (Eng.). Applied to a bed of coal immediately below the 10-yard coal, Staffordshire. (Bainbridge)

Heath peat. Peat derived chiefly from decomposed heather. (Standard)

Heating back. A chamber back of a forge, in which the air intended for the blast is heated. (Standard)

Heating furnace. The furnace in which blooms or piles are heated before hammering or rolling. (Raymond)

Heating surface. That surface in a steam boiler or similar apparatus from which the heat passes to the liquid to be evaporated or heated; the fire surface. (Standard)

Heat of combustion. The heat evolved when a substance is completely burned in oxygen.

Heating tube. A water tube exposed to the fire in a steam boiler. (Standard)

Heat recuperation. The recovery of heat from waste gases. (Ingalls, p. 355)

Heat unit. A unit of quantity of heat; the heat required to raise the unit mass of water through one degree of temperature (Standard). *Compare* Calorie; *also* British thermal unit.

Heave. 1. The horizontal component of the slip, measured at right angles to the strike of the fault. Used by J. E. Spurr and A. Geikie for "offset." Used by Jukes Brown for "strike slip." (Lindgren, p. 123)
2. A rising of the floor of a mine caused by its being too soft to resist the weight on the pillars. (Steel)

Heavily watered (Scot.). Said of a colliery when the escape of water from the strata into the shaft or workings is abundant, requiring powerful pumping machinery. (Barrowman)

Heavy. The hollow sound produced when knocking on a mine roof, which is loose. (Gresley)

Heavy fire (No. of Eng.). An extensive and severe explosion. (Gresley)

Heavy gold (Aust.). Particles of gold the size of gunshots. (Davies)

Heavy spar. Synonym for Barite.

Heavy tiff. *See* Tiff, 2.

Hebilla (Sp.). A buckle. (Halse)

Hebrew granite (Eng.). A graphic granite in which the crystals of quartz imbedded in the body of the feldspar resemble Hebrew characters. (Roberts)

Hechado (Sp.). The dip of a lode. (Lucas)

Hectare. A measure of area equal to 2.4711 acres.

Hedenbergite. A calcium-iron variety of pyroxene, $CaFe(SiO_3)_2$. (Dana)

Hedgehog. 1. (Scot.) A broken strand or single wire of a rope torn out while the rope is in motion, and drawn up into a knot or bundle on the rope. (Barrowman)
2. A dredger consisting of a roller with protruding spikes or spades which is dragged over the bottom of a river, etc., to remove silt, mud, or the like. (Webster)

Hedgehog stone. Quartz crystals containing needles of göthite or some other iron oxide (Chester). *Compare* Hair stone.

Hedrumite. A name proposed by Brögger for certain syenitic rocks that are poor or lacking in nephelite, but that have a trachytic texture. (Kemp)

Heel. The mouth or collar of a bore hole. (Du Pont)

Heel of a shot. In blasting, the front of a shot, or the face of the shot farthest from the charge (C. and M. M. P.). Same as Heel.

Heel of coal. A small body of coal left under a larger body as a support. (Steel)

Heepstead (Eng.). *See* Heapstead.

Hegeler furnace. A muffle furnace 7 hearths high. The lower hearths are heated by gas burned in the flues beneath them. The first mechanical furnace to be employed successfully for blende roasting in the United States, at La Salle, Ill. (Ingalls, pp. 145 and 450)

Hegeler producer. A furnace for the manufacture of producer gas. (Ingalls, p. 307.)

Height-of-land. *See* Watershed.

Heintzite; Hintzeite; Kaliborite. A hydrous borate of magnesium and potassium. The mineral occurs in small crystals sometimes aggregated. Colorless to white. From Stassfurt. (Dana)

Helenite. A wax near ozocerite but elastic like caoutchouc; it is yellow and has a specific gravity of 0.915. It occurs at Ropa in Galicia. (Bacon)

Helictite. A distorted twig-like lateral projection of calcium carbonate, found in caves, etc. (Standard). *Compare* Stalactite; Stalagmite.

Heliotrope. A subspecies of quartz, of a deep-green color, peculiarly pleasant to the eye. Also called Bloodstone. (Century)

Helium. An inert, monatomic, gaseous element occurring in the atmosphere of the sun and stars, and in small quantities in the earth's atmosphere, in several minerals and in certain mineral waters. Symbol, He; atomic weight, 4.0; specific gravity, 0.12. (Webster)

Helper. A miner's assistant, who works under the direction of the miner. (Hargis)

Helper-up (Aust.). An assistant to a trammer when the roads are bad. (Power)

Helve. 1. (Eng.) The handle of a pick or maundrill (Gresley). Sometimes called Helver.
2. A lift-hammer for forging blooms. (Raymond)

Helvite. A mineral occurring commonly in tetrahedral crystals; also in spherical masses. Brittle; luster vitreous, inclining to resinous. Color honey-yellow, inclining to yellowish brown, and siskin green, reddish brown. Composition, $(Be, Mo, Fe)_7Si_3O_{12}S$. (Dana)

Hemachate. A light-colored agate spotted with red jasper. Also called Blood-agate. (Standard)

Hematita (Sp.). Hematite. (Dwight)

Hematite. One of the commonest ores of iron, Fe_2O_3, which when pure contains about 70 per cent of metallic iron and 30 of oxygen. It may be readily distinguished from magnetic and titaniferous iron ore by its red streak and powder, the others giving a black streak. Hematite is sometimes mixed with sufficient magnetite to cause it to adhere to the magnet. The hydrated variety of this ore is called limonite or brown hematite. (Roy. Com.)

Hematitic. Pertaining to, containing, or resembling hematite. (Century)

Hembra (Mex.). A post (timbering). (Dwight)

Hemidome. That form in a crystal composed of two parallel domatic planes in the triclinic, or of two parallel orthodomatic planes in the monoclinic system of crystallization. (Standard)

Hemihedral. In crystallography, having a lower grade of symmetry than, and only half as many faces as, the corresponding form of full or normal symmetry for the system. (La Forge)

Hemiholohedral. Noting hemihedrons in which all the octants contain half the whole number of similar planes. (Standard)

Hemimorphic. In crystallography, having no transverse plane of symmetry and no center of symmetry, and composed of forms belonging to only one end of the axis of symmetry. (La Forge)

Hemimorphite. A hydrous zinc silicate, H_2ZnSiO_5 (Dana). *Compare* Calamine.

Hemiprism. A form produced by two parallel planes cutting the two lateral axes in the triclinic system of crystallization. (Standard)

Hemipyramid. A form consisting of two pairs of similar parallel planes cutting all three axes in the monoclinic system of crystallization. (Standard)

Hemithrene. Brogniart's name, current among the French, for certain dioritic rocks that contain a large amount of calcite, presumably an alteration product. (Kemp)

Hemitropic. Crystals that appear as if composed of two halves of a crystal turned partly round and united. Examples of this structure may be often found in feldspar and cassiterite crystals. (Jackson)

Henderson process. The treatment of copper sulphide ores by roasting with salt, to form chlorides, which are then leached out and precipitated. Henderson originally proposed to volatilize the chlorides, and the leaching and precipitation are not original with him. Longmaid and many other metallurgists have proposed them in various modifications. (Raymond)

Hepatic cinnabar. A variety of cinnabar of a liver-brown color. (Webster)

Hepatic gas. An old chemical term for hydrogen sulphide. (Webster)

Hepatic mercurial ore. *See* Hepatic cinnabar.

Hepatic pyrite. Marcasite. (Power)

Hepatin. An amorphous limonite, of a liver-brown color, and containing a small percentage of copper. (Chester)

Hepatite. A variety of barite: so called from the fetid odor it exhales when heated. (Standard)

Hercules powder. An explosive that resembles dynamite No. 2, and consists of nitroglycerin with a more or less explosive dope. (Raymond)

Hercules stone. The lodestone. Called also Heraclean stone; Heraklean stone. (Standard)

Hercynite. Iron spinel, $FeAl_2O_4$. Isometric; a massive, fine granular black mineral. (Dana)

Hermetic casing. *See* Screw casing.

Heronite. A name proposed by A. P. Coleman, for a dike rock, consisting essentially of analcite, orthoclase, plagioclase and aëgirite, the analcite having the character of a base, in which the other minerals form radiating groups of crystals. The name is derived from the locality, Heron Bay, on the north shore of Lake Superior. (Kemp)

Herramienta (Mex.). Tools; equipment. In Guanajuato used instead of *Parada.* (Dwight)

Herrar (Sp.). To shoe horses. (Halse)

Herrería (Sp.). 1. A blacksmith's shop. 2. Ironworks. 3. A forge. (Halse)

Herrero (Sp.). Blacksmith. (Dwight)

Herreshoff furnace. 1. A rectangular-shaft blast furnace for smelting copper ore. (Peters, p. 287)
2. A mechanical, cylindrical, multiple-deck, muffle furnace of the McDougall type. (Ingalls, p. 152)

Herringbone. 1. Resembling the spine of a herring, characterized by the arrangement of materials in rows of parallel lines, which in any two successive rows slope in reverse directions. 2. A gear with double-screw teeth. (Webster)

Herringbone work. 1. Masonry in which the stones are laid slanting in opposite directions in alternate courses. 2. An arrangement of diagonal struts in X forms between joists to communicate strength from one joist to its neighbors. (Standard)

Hervezón (Colom.). Alluvium mixed with poor sands or superficial earth. (Halse)

Hervidero (Sp.). 1. A boiling spring. 2. A mud volcano. (Halse)

Hervir (Sp.). To boil. (Dwight)

Hess (So. Staff.). Clinker from furnace boilers. (Gresley)

Hessite. A silver telluride mineral, Ag_2Te. Contains 63.3 per cent silver. (U. S. Geol. Surv.)

Hessonite. A variety of garnet; Cinnamon stone. (Century)

Heterogeneous. Differing in kind; having unlike qualities; possessed of different characteristics; opposed to homogeneous. (Webster)

Heterotactous. Irregular; lacking uniformity in stratification or arrangement of parts; heterogeneously arranged. (Standard)

Heterotomous. Having a cleavage unlike that which is characteristic of the mineral in its ordinary form, as a variety of feldspar. (Standard)

Heugh (Scot.). 1. A place where coal or other mineral is worked; a pit or shaft. (Barrowman)
2. A gem with rugged sides; a crag (Standard). *Also* spelled Heuch.

Heulandite. A mineral of the zeolite family. A hydrous silicate of calcium and aluminum, $5H_2O.CaO.Al_2O_3.6SiO_2$. (Dana)

Heumite. A name proposed by W. C. Brögger for a dike rock, composed of minerals, too small to be recognized with the eye alone, but which under the microscope prove to be natron-orthoclase, natron-microcline, barkevicite, biotite, and in small amount, nephelite, sodalite, and diopside. The accessories are apatite, magnetite, pyrite, and titanite. The silica in two dikes was found to be respectively 47.10 and 48.46. The name was derived from Heum, a small town on Lake Farris. (Kemp)

Hewer (Newc.). One who undercuts the coal with a pick. A coal miner.

Hewing (Newc.). Undercutting or mining the coal. (Min. Jour.)

Hewing double (Eng.). *See* Double-working. (G. C. Greenwell)

Hewing rate (Aust.). The rate of pay given miners for mining coal. (Power)

Hewns (Eng.). The sides of a calciner or roasting furnace, from their being formerly built with hewn stone. (Pryce)

Hexagonal system. In crystallography, that system of crystals in which the faces are referred to four axes, a principal or vertical axis and three lateral axes perpendicular to the vertical axis and intersecting at mutual angles of 60°. (La Forge)

Hexahedron. In crystallography, a form, in the isometric system, enclosed by six faces each perpendicular to an axis; a cube. (La Forge)

Hexoctahedron. In crystallography, a form, in the isometric system, enclosed by 48 similar faces with unequal intercepts on all three axes. (La Forge)

Hextetrahedron; Hexatetrahedron. In crystallography, a form, in the isometric system, of tetrahedral symmetry, enclosed by 24 similar faces with unequal intercepts on all three axes. (La Forge)

Hiatal. A rock fabric in which the variation in the size of the crystals is not in continuous series, but in a broken series with hiatuses. (Iddings, Igneous Rocks, p. 198)

Hiatus. A chasm; a gap; a space where something is wanting. (Webster)

Hichú (Peru). A species of long grass used as fuel or fodder. (Dwight)

Hick-joint. A system of masonry-pointing in which the mortar between the courses is flush with the face of the wall. (Standard)

Hiddenite. An emerald-green spodumene. Used as a gem. (U. S. Geol. Surv.)

Hidráulica (Sp.). Hydraulic. (Dwight)

Hidrografía (Mex.). Hydrography. (Dwight)

Hielmite. A stanno-tantalate (and niobate) of yttrium, iron, manganese, calcium. Crystals (orthorhombic), usually rough; massive. Color pure black. From Sweden. (Dana)

Hierro (Sp.). 1. Iron; *H. afinado*, refined iron; *H. cochino*, pig iron; *H. colado*, cast iron. 2. Iron ore; *H. arcilloso*, clay ironstone; *H. arsenical*, arsenopyrite; *H. especular*, specular iron ore; *H. cromado*, chrome iron ore (Lucas). *H. labrado*, wrought iron (Min. Jour.); *H. limoso*, bog ore; limonite; *H. magnético*, magnetite; *H. pardo*, brown iron ore; *H. rojo*, hematite; *H. viejo*. (Peru) Silver ores consisting mainly of iron oxide. (Halse)

Higado (Peru). 1. An oxide of iron, occurring in small isolated masses, containing minute particles of gold. 2. A lenticular deposit of gold ore. (Halse)

High. A miner's name for the coal of a thick seam. (Steel)

High doors (Scot.). An upper landing in a shaft. (Barrowman)

High explosives. Explosives which detonate or are composed of ingredients which detonate. In the United States the designation covers explosives like gelatin, dynamite, blasting gelatin, etc., which are stronger and more sudden in their action than gunpowder. (Du Pont)

High furnace. The ordinary blast furnace. (Century)

High-grade. 1. An arbitrary designation for dynamite of 40 per cent strength or over. *See* Grade, 5. (Du Pont)
2. Rich ore. 3. To steal or pilfer ore or gold, as from a mine by a miner. *See* High-grading.

High-grade mill. A plant for treating high-grade ores.

High-grade ore. Rich ore. *Compare* Low-grade ore.

High-grader. One who steals and sells, or otherwise disposes of high-grade or specimen ores. A common practice in the early days of gold mining.

High-grading. Larceny of small particles of ore or gold by employees in a mine. (Goldfield Cons. Mines Co. *v.* Richardson, 194 Fed. Rept., p. 200)

High pillar. *See* Shaft pillar.

High-reef. A bedrock which frequently rises more abruptly on one side of a channel or water course than on the other. (C. and M. M. P.)

High-reef wash. A term usually applied to deposits of wash dirt upon the high-reef. (Duryee)

High side. A deep coal-mine car, *i. e.* one with high sides. *Compare* Gondola, 1.

High steel. Steel containing a large proportion of carbon. (Standard)

High values (Transvaal). Ore having a high assay value. (Rickard, Journal Chem. Met. and Min. Soc. of S. Africa, Jan. 1914, p. 361)

Hijuela (Sp.). 1. A small thread of ore or mineral. 2. A small drain. (Dwight)

Hijuelas (Mex.). A small-size torta, made up as a sort of assay on a large scale, with from 1 to 5 kilogrammes of argentiferous mud. (Dwight)

Hilera (Peru). A parting in a coal seam. (Halse)

Hilera costeable (Sp.). Pay streak. (Lucas)

Hill. 1. An arch or high place in a mine. (Roy)
2. (Scot.). The surface at a mine. (Barrowman)
3. (No. of Eng., Mid.) An underground inclined plane. (Gresley)
4. A natural elevation of land of local area and well defined outline. (Webster)

Hill clerk (Scot.). The person who weighs mineral, whether at the mine or depot connected therewith. (Barrowman)

Hill diggings. Placers on hills. (C. and M. M. P.)

Hiller. In pottery, a vessel used in making the glaze. (Standard)

Hillman; Hillsman. 1. (Scot.). A pit headman; a hill clerk. 2. A coal salesman. (Barrowman)

Hillock (Eng.). A heap of sterile vein-stuff or stone. (Hunt)

Hill sale (Scot.). Sale of coal at the mine in carts, as distinguished from shipment in railway cars. (Barrowman)

Hillside placers (Alaska). Placers on slopes, intermediate between creek and bench claims. (Purington, C. W., Bull. 259, U. S. Geol. Surv., p. 33)

Hilo. 1. (Mex.) Thread; pay streak; small stringer of ore. 2. (Peru) Strike of a vein. (Dwight)
3. *H. altos* (Sp.) Threads or small veins of ore extending into the upper or hanging wall. 4. *H. bajos*, Threads or small veins of ore extending into the lower or foot wall. (Min. Jour.)

Hindostan. A fine-grained sandstone used extensively in the manufacture of very cheap sharpening stones, especially axe stones. Found in Indiana. (Pike)

Hinged-hammer crusher. *See* Williams Hinged-hammer crusher.

Hinge fault. *See* Fault.

Hinging coal (Scot.). Coal lying at a moderately high inclination. (Barrowman)

Hinsdalite. A mineral related to alunite, but with replacements as indicated in the following formula: $2PbO.3Al_2O_3.2SO_3.P_2O_5.6H_2O$. (U. S. Geol. Surv.)

Hintzeite. *See* Heintzite.

Hip-and-ridge angle. A piece of roofing tile required where a hip starts from a ridge. (Ries)

Hip roll. A tile used for covering the hips on roofs, and which in cross section may show either roll or an angle. (Ries)

Hip roll starter. A closed hip piece of roofing tile used at the lower end of a hip roll. (Ries)

Hip tile. A tile made to fit the hip of a roof. (Standard)

Hircine. A fossil amorphous resin, the composition of which has not been determined. (Century)

Hirst. A bank of sand in or along a river. (Standard)

Hislopite. A grass-green variety of calcite in which the color is due to admixed glauconite. (Standard)

Historical geology. *See* Geology.

Hit (Eng.). To find, prove, or cut into a coal seam or fault. (Gresley)

Hitch. 1. (Scot. and Newc.) A minor dislocation of a vein or stratum not exceeding in extent the thickness of the vein or stratum. 2. A hole cut in the side rock, when this is solid enough, to hold the cap of a set of timbers, permitting the leg to be dispensed with. (Raymond)
3. To attach trams to hauling ropes by short chains. (Gresley)
4. A sudden stoppage of pumping machinery. (Standard)

Hitch-and-step (So. Wales). A system of regulating the distance between the faces of stalls in longwall work. (Gresley)

Hitch cutter. A miner who cuts places in the coal, ore, or wall in which to rest or place timbers to prevent rock from falling. (Andrews *v.* Tamarack Min. Co., 114 Michigan, p. 375; 72 N. W. Rept., p. 242; Danula *v.* Quincy Min. Co., 166 Michigan, p. 351; 130 N. W. Rept., p. 604; Andrews *v.* Tamarack Min Co., 180, Michigan, p. 73)

Hitcher. The man who runs trams into or out of the cages, gives the signals, and attends at the shaft when men are riding in the cage. (Gresley). *See also* Cager.

Hitcher-on. The person employed at the bottom of a shaft or slope to put loaded cars on, and take empty cars off the cage. (Roy)

Hitch wheels (So. Staff.). Drums upon which winding bands (chains) coil. (Gresley)

Hoarding (Eng.). A temporary closed fence of boards placed around a work in progress. (C. and M. M. P.)

Hoarstone. A stone designating the bounds of an estate; a landmark. (Webster)

Hoastman (Local, Eng.). A member of the principal civic corporation of Newcastle-on-Tyne; formerly, a member of a merchant gild of that place which received strangers that came to buy coal and certain other commodities, conducted the purchases, and levied upon them a certain duty. In later times the gild controlled the selling and exportation of coal. (Standard)

Hobo connection. Same as Parallel connection, as used in blasting. (Du Pont)

Hod. 1. (Forest of Dean) A cart or sled for conveying coal in the stalls of thin seams. (Gresley)
2. A wooden tray or trough with a handle, borne on the shoulder, for carrying bricks, mortar, etc. (Webster)

Hock. A corner or angle, as between mountains; a secluded valley. (Standard)

Hofmannite. A crystalline, colorless, tasteless, and odorless mineral, possessing a specific gravity of 1.0565; it melts at 71° C. and has the composition $C_{20}H_{36}O$. It forms a white crystalline efflorescence on lignite in the vicinity of Sienna. (Bacon)

Hogar (Mex.). Hearth of a furnace. (Dwight)

Hogback. 1. (Eng.) A sharp rise in the floor of a coal seam. (Gresley)
2. A ridge formed by the outcropping edge of tilted strata; hence any ridge with a sharp summit and steeply sloping sides, as an esker (Webster). Called also Horseback.

Hoggan (Corn.). The food carried by the miner to the mine. (Davies)

Hogger. 1. (Scot.) A leather or canvas delivery pipe at the top of a sinking set of pumps. (Barrowman) 2. (No. of Eng.) Stockings without feet, worn by coal miners. (Gresley).

Hogger pipe (No. of Eng.). The upper terminal pipe with delivery hose from the mining pump. (Century)

Hogger pump. The topmost pump in a shaft. (Raymond)

Hoggin. A material composed of screenings or siftings of gravel or a mixture of loam, sand, and gravel, used in making filter beds, as a binding material for metal roads, or the like. (Webster)

Hog-tooth spar. Like a dog-tooth spar, a name for calcite, occurring in acute scalenohedrons. (Chester)

Hohenlohehütte furnace. A retort furnace for the distillation of zinc. (Ingalls, p. 408)

Hoist. 1. An engine for raising ore, rock, coal, etc., from a mine and for lowering and raising men and material. Also called Hoister. 2. The amount of ore, coal, etc., hoisted during a shift.

Hoisting block. The lower block of a block-and-fall, bearing the hoisting hook. (Standard)

Hoisting crab. A crab, winch, or windlass for hoisting. (Standard)

Hoisting engineer; Hoist man. One who operates a hoisting engine, especially at a mine or quarry. Also called Engineman.

Hoisting jack. A device for applying hand power to lift an object by means of a screw or lever, or by hydraulic power. (Century)

Hoisting rope. A rope composed of a sufficient number of wires and strands to insure strength and flexibility. Such ropes are used in shafts, elevators, quarries, etc. (C. M. P.) *See* Cable, 1 and 3.

Hoja (Sp.). Leaf; sheet; *H. de pizarra*, a slab of slate; *H. de libro*, (Mex.) a black schistose rock; *H. de papel*, finely laminated clay, slate or talc. (Halse)

Hojalata (Sp.). Tin plate. (Halse)

Hojalatero (Mex.). Tinsmith. (Dwight)

Holding iron. *See* Furnace holding iron.

Hold out! (Derb.). An exclamation by the banksman, down a shaft to the bottomer, when men are about to descend the shaft, to let him know that he is not to send up a load of coal, but merely the empty rope or chain. (Gresley)

Hole. 1. To undercut a seam of coal by hand or machine. 2. A bore hole. 3. To make a communication from one part of a mine to another. (Steel)
4. (Joplin, Mo.) A local term for a mine shaft.

Hole man (Penn.). One who loads holes with explosives; a charger. (De Nardo *v.* Stephens-Jackson Co., Penn. 104 Atlantic, p. 585)

Holes (No. of Eng.). The different stages or floors from which the cages are loaded at the shaft bottom. (Gresley)

Hole system. A system of contract work underground by which the pointing of the holes and blasting are done by company men and the rest of the work by the miner. (H. C. Hoover, p. 165)

Holing. 1. The working of a lower part of a bed of coal for bringing down the upper mass. 2. The final act of connecting two workings underground. (Raymond)

Holing about (Eng.). The operation of establishing an air current between the down-cast and up-cast shafts. (G. C. Greenwell)

Holing-pick. A pick used in holing coal. (Standard)

Holing-shovel (So. Staff.). A short-handled, round-bladed shovel. (Min. Jour.)

Holing-through. Driving a passage through to make connection with another part of the same workings, or with those in an adjacent mine (Chance). *See also* Holing, 2.

Hollin (Mex.). Fume; condensed furnace-smoke; soot. (Dwight)

Hollow blocks. Hollow tiles, larger than common brick, usually of rectangular form, and having some cross webs. Used in exterior walls and also partitions. (Ries)

Hollow brick. Brick molded with hollow spaces in them. They are usually strengthened by cross webs. (Ries)

Hollow-fire (Eng.). A kind of hearth with blast, used for reheating the blooms produced in the South Welsh process of fining, or the bars of blister-steel in the manufacture of shear-steel. (Raymond)

Hollow lode (Aust.). A lode filled with rugs. (Power)

Hollow-plunger pump. A pump used in mining and quarrying, as in muddy and gritty water. (Standard)

Hollow reamer. A tool for straightening a crooked borehole. (Gresley)

Hollows (Eng.). Old abandoned workings. (Gresley)

Hollow spar. Andalusite.

Holway process. A process for the removal of sulphur from iron and copper sulphides by fusion and pneumatic treatment, analogous to the manner in which carbon, etc., are removed in the Bessemer process. (Raymond)

Holmium. A chemical element of the rare-earth group, not yet definitely isolated. Symbol, Ho; atomic weight, 163.5.

Holocrystalline. A textural term applied to those rocks that consist entirely of crystallized minerals as distinguished from those with more or less glass. (Kemp)

Holohedral. In crystallography, possessing all the faces that have equivalent intercepts required by the symmetry of the group to which the form belongs. (La Forge)

Holohedron. A form having the full number of symmetrically arranged planes crystallographically possible. (Standard)

Holohemihedral. Denoting hemihedrons in which all the sectants have half instead of the whole number of similar planes. (Standard)

Holohyaline. Completely glassy. (Iddings, Igneous Rocks, p. 187)

Holomorphic. Uniformly or completely symmetrical. (Standard)

Holosiderite. Meteoric iron; a meteorite consisting of metallic iron without stony matter. (Webster)

Holystone. A soft sandstone used to scrub decks. To scrub with holystone. (Webster)

Home (No. of Eng.). In the direction of, or toward the shaft, as in an underground mine. (Gresley) Outby.

Homestead act (U. S.). An act of Congress authorizing the sale of public lands in parcels of 160 acres each, to settlers.

Homestead entry. An entry under the statute enacted to secure homesteads to actual settlers on the public lands. (Hartman *v.* Warren, 76 Fed. Rept., p. 160)

Homichlin. A variety of chalcopyrite that is partly altered to bornite. (Standard)

Homilite. (Norway). A black, blackish brown mineral, $(Ca,Fe)_3B_2Si_2O_{10}$. Crystals often tabular. (Dana)

Homocline. In geology, a group of inclined beds of the same dip, which may be either monoclinal, one limb of a fold, or isoclinal, but whose actual relations are not determinate (La Forge). Used in a more restricted sense than a monocline in that it applies to small or fragmentary areas.

Homoeomorphism. A near similarity of crystalline forms between unlike chemical compounds. (Power)

Homogeneous. Of the same kind or nature; consisting of similar parts, or of elements of a like nature; opposed to heterogeneous. (Webster)

Homogeneous metal. A variety of ingot metal produced by the open-hearth process, for example, steel. (Raymond)

Homogeneous steel. Cast steel without blowholes. (Standard)

Honda (Mex.). A rope chair for descending a shaft. A sling. (Dwight)

Hondonada (Sp. Am.). An excavation. (Lucas)

Hondura (Colom.). A sudden depression in the surface of the bed rock of placer mines. (Halse)

Hone. An extremely fine-grained sandstone suitable for sharpening razors or other fine-edged instruments or tools. (Bowles)

Honestone. A stone suitable for making hones for sharpening; also, a hone ready for use. (Webster)

Honeycomb. Any substance, as cast-iron, worm-eaten wood, etc., having cells suggesting a honeycomb (Webster). Also applied to certain rock structures.

Honeycomb dun (Eng.). A Devonshire name for a vesicular, schistose, trappean rock. (Roberts)

Honey-stone. A mellate of aluminum, $Al_2C_{12}O_{12}+18H_2O$, of yellowish or reddish color, and a resinous aspect, crystalizing in octahedrons with a square base. The mineral is harder than gypsum, but not so hard as calcite. (Dana)

Hoo cannel (Eng.). Impure earthy cannel coal. (Gresley)

Hood. 1. *See* Bonnet, 1. 2. The top of a pump. (Standard)

Hook block. The lower sheave or block, on a crane hoist, to which a swivel hook is attached. (Willcox)

Hooker-on. Same as Hook-on; also Hanger-on.

Hook handles (Corn.). The handles by which a windlass is worked. (Min. Jour.)

Hook-on. The man who adjusts cables or chains, about objects to be lifted; places hook of crane-block in bucket bails, and hooks of winches to objects to be moved, etc. (Willcox)

Hookworm. *See* Ankylostomiasis.

Hopes (No. of Eng.). Valleys formed by denudation of the coal measures of the County of Durham. (Gresley)

Höpfner process. A process for the recovery of copper in which a solution of cuprous chloride in sodium or calcium chloride is used to dissolve copper sulphides. The solution is then electrolyzed in tanks with diaphragms. The anodes are impure copper, the cathodes pure copper. Copper is deposited from the cuprous chloride solution, and cupric chloride regenerated. (Liddell)

Hopper. 1. A trap at the foot of a chute for regulating the contents of a wagon. 2. A place of deposit for coal or ore. (Raymond)
3. A funnel-shaped feeding trough.
4. (Derb.) A dish used by miners to measure ore. It varies from 14 to 16 pints in different localities. (Mander)

Hopper car. A car for coal, gravel, etc., shaped like a hopper, with an opening at the bottom to discharge the contents. (Standard)

Hopperings. In gold washing, gravel retained in the hopper of a cradle.

Hopper-truck (Aust.). *See* Hopper car.

Hoppet. 1. (Eng.) A hoisting bucket. (Webster)
2. A vessel for measuring ore. (Standard)

Horbachite. A metallic, dark-yellow, iron-nickel sulphide that is closely related to pyrrhotite, and is found as a massive mineral. (Standard)

Horca (Sp.). Hoist; gallows frame; headgear. (Halse)

Horizon. 1. In geology, any given definite position or interval in the stratigraphic column or the scheme of stratigraphic classification: generally used in a relative sense. 2. As used by some British geologists, one or several consecutive beds characterized by a certain fossil or fossils; a zone. (La Forge)

Horizontal-cut underhand. *See* Underhand stoping.

Horizontal fault. *See* Fault.

Horizontal slicing (ascending). *See* Overhand stoping.

Horizontal slicing (descending). *See* Top-slicing and cover-caving.

Horizontal throw. *See* Heave.

Horley-Sedgley water finder. An instrument used for ascertaining the amount of water in a tank containing oil. (Mitzakis)

Hormigón (Sp.). Concrete (Lucas)

Hormiguillar (Peru). To add salt and some water to the amalgamating charge. (Dwight)

Hormiguillo (Peru). 1. A line of laborers who pass material from hand to hand. 2. The second treading in the *patio* process before mercury is added. (Halse)

Horn. 1. (Derb.) A line at an angle of 45° with the face of the coal. (Min. Jour.)
2. *See* Spoon, 1.

Hornacho (Sp.). 1. A mine shaft. *See* Pozo. 2. An excavation made in the hillside in search of ore. (Halse)

Hornada (Sp.). One complete smelting operation in any furnace. (Halse)

Hornblende. A variety of the mineral amphibole. Color between black and white, through various shades of green, inclining to blackish green; also dark brown; rarely yellow,

pink, rose-red. In part a normal metasilicate of calcium and magnesium, $RSiO_3$, usually with iron, also manganese, and thus in general analogous to the pyroxenes. The alkali metals, sodium and potassium, also present, and more commonly so than with pyroxene. (Dana). The name of the mineral is prefixed to many rock names.

Hornblende schist. In petrology, a schistose rock, generally metamorphic, composed essentially or chiefly of hornblende. (La Forge)

Hornblendite. A granitoid, igneous rock, consisting essentially of hornblende and analogous to pyroxenite. (Kemp)

Horn coal. 1. (Eng.) Coal worked partly end-on and partly face-on. (Gresley)
2. A variety of cannel coal from South Wales. (Bacon)
3. A coal that emits, when burning, an odor like that of burnt horn. (Power)

Hornfels. A dense, compact rock produced from slate by the contact action of some igneous intrusion, especially granite. Various microscopic minerals are developed in it. (Kemp)

Hornillo (Sp.). 1. A small oven or furnace. 2. A portable assay furnace. 3. A mud volcano. (Halse)

Hornito. A gas-emitting vent on, and originating in a lava flow (Daly, p. 135). A low, oven-shaped mound common in the volcanic districts of South America, usually emitting from its sides and summit hot smoke and other vapors. (Century)

Horn lead. Lead chloride. (Century)

Horno (Sp.). 1. A kiln; *H. de cal*, a lime kiln. 2. A furnace; *H. alto*, a blast furnace; *H. acoplado*, a double-hearth furnace; *H. castellano*, a low, shaft furnace; *H. cubierto*, a jacket furnace; *H. de afinación*, a refining furnace; *H. de cuba*, a shaft furnace, generally a blast furnace; *H. de fundición*, a smelting furnace (Lucas); *H. de magistral*, roasting stove, for copper pyrites (Min. Jour.); *H. de reverbero*, a reverberatory furnace; *H. de tostar*, a roasting furnace. (Halse)

Horn quicksilver. Mercurous chloride, Hg_2Cl_2. Calomel. (Dana)

Horns (Eng.). Guides on the winding drum to keep the rope in place. (Bainbridge)

Horn silver. Chloride of silver. *See* Cerargyrite. (Dana)

Horn socket. In well boring, an implement to recover lost tools, especially broken drill poles, etc. It consists of a conical socket, the larger end downward, which slides over the broken part, a spring latch gripping it when entered. Frequently a flaring mouthpiece is riveted to the horn socket, making it a bell-mouth socket. (Nat. Tube Co.)

Horn spoon. A longitudinal section, cut from the under side of an ox horn and scraped thin; used for washing auriferous gravel and pulp where delicate tests are required (Hanks). *See also* Spoon, 1.

Hornstone; Chert. An impure flint or chalcedony with splintery fracture. More brittle than flint. (U. S. Geol. Surv.)

Horny (Scot.). An inferior kind of gas coal, the pieces of which rattle with a sound suggestive of horns. (Barrowman)

Horn tiff (Mo.). Calcite stained with carbonaceous material; sometimes dark enough to be mistaken for sphalerite.

Horquilla (Mex.). A coke-fork. (Dwight)

Horse. 1. A mass of country rock lying within a vein. (Book *v.* Justice Mining Co., 58 Fed. Rept., p. 125)
2. Any irregularity cutting out a portion of the vein. (Consol. Wyoming Gold Mining Co. *v.* Champion Mining Co., 63 Fed. Rept., p. 544; Barrett *v.* Dessy, 78 Kansas, p. 644; 97 Pacific, p. 786.) *See* Dirt-fault and Rock-fault. *To take horse.* To split into branches as a vein of ore in a mine. (Standard)
3. (Scot.). A seat suspended from a crane rope in a shaft (Barrowman). *See also* D. Link.
4. (Eng.). In saltmaking, to set the lumps of salt upon the top of each other in the hothouse. (Webster)

Horse arm (Eng.). The part of a whim to which the horses are attached. (Bainbridge)

Horseback. 1. Natural channels cut or washed away by water in a coal seam, and filled up with shale and sandstone. Sometimes a bank or ridge of foreign matter in a coal seam. 2. A portion of the roof or floor which bulges or intrudes into

the coal. 3. A mass of country rock lying within a vein or bed (Steel). *See also* Horse, 1.
4. A piece of slate, flat underneath, thick in the middle, and running out to a thin edge upon each side (Stratton *v.* Northeast Coal Co., 164 Kentucky, p. 303). *See also* Kettle bottom.
5. (Maine) A low and somewhat sharp ridge of sand or gravel; also, but not generally, a ridge of rock which rises for a short distance with a sharp edge. A hogback. (Century)

Horse beans (Ches.). A stratum of a granular rock immediately overlying salt beds, in which brine occurs (Gresley). Also called Shaggy metal.

Horse block; Horsing block. A frame of timber on which to rest the raised end of an excavator's wheeling plank. (Webster)

Horse engine; Horse gin (Scot.). A winding drum driven by horse power for raising mineral. (Barrowman.)

Horse fettler (So. Staff.). A man who looks after the underground horses and ponies. (Gresley)

Horseflesh ore (Corn.). Bornite. (Raymond)

Horse gin. Gearing for hoisting by horse power. (Hanks)

Horsehead (Eng.). A wooden box used for mine ventilation. (Bainbridge)

Horse height (Mid.). Sufficient distance between the floor and the roof, for a horse to travel without knocking his head. (Gresley)

Horse-in-the-lode (Eng.). A dead or worthless part in the lode; generally composed of fragments of the strata through which the lode passes, which invariably divides the lode (Hunt). *See also* Horse, 1.

Horse load (Eng.). A measure of weight used in some parts of East Lancashire. 1 horse load=4 cwt.; 5 horst loads equal one ton. (Gresley)

Horse platform (Scot.). The switch and crossing used on (including the rails) a horse-haulage road. (Barrowman)

Horseplay. Rude or boisterous play (Webster). Often results in serious accidents at mines and industrial plants.

Horsepower. A unit of power numerically equal to a rate of 33,000 foot pounds of work per minute (=550 foot pounds per second) used in stating the power of a steam engine or other prime mover. (Webster)

Horsepower hour. The work performed, or energy consumed, by working at the rate of one horsepower for one hour. It is equal to 1,980,000 foot pounds. (Webster)

Horse pump. An ordinary lifting pump worked by horse power. (Duryee)

Horse road. An underground way for horse haulage. (Gresley)

Horse run. A device by means of which horses draw loaded vehicles up an incline from excavations. (Standard)

Horse shovel. A road scraper. (Century)

Horses' teeth (Corn.). A quarryman's term for white elongated crystals of feldspar, which gives the granite its porphyritic character. (Power)

Horse tree (Eng.). A strong timber beam for supporting pumps. (Gresley)

Horseway. A road fit for travel with a horse. (Webster)

Horse whim. A horse-power winding drum for raising ore from a mine. A horse gin.

Horsfordite. A silver-white, massive copper antimonide, probably Cu_2Sb, occurring in Asia Minor. (Dana)

Horsing (Eng.). Drawing trams underground by horses and ponies. (Gresley)

Horst. A tract of the earth's crust separated by faults from the surrounding tracts which have been relatively depressed (Webster). Also spelled Horste.

Horwood process. A flotation process in which if a mixture of iron, copper, lead, and zinc sulphides is roasted, the three former can be changed to oxide and sulphide at a comparatively low temperature, whereas the blende is practically unaltered. The partly roasted material is then subjected to a heated-acid oil-flotation process, by which the zinc is floated, the other metals staying behind. (Liddell)

Hose. 1. A strong flexible pipe made of leather, canvas, rubber, etc., and used for the conveyance of water, or air under pressure, to any particular point. (C. and M. M. P.) 2. (Scot.) A rope shackle; an iron clasp at the end of a rope. (Barrowman)

Host. A mineral that contains another (Standard). *Compare* Hair stone.

Hot. A term applied to a mine or part of a mine that generates methane in considerable quantities.

Hotbed. A platform in a rolling mill on which rolled bars lie to cool. (Raymond)

Hot-blast. Air forced into a furnace after having been heated. (Raymond)

Hot-blast man. A stove tender at blast furnaces. (Willcox)

Hot-blast system. In ventilation, the plenum system. (Webster)

Hot-cast porcelain. *See* Opaline.

Hotching (Eng.). Jigging, as of lead ore. (Ure)

Hot chisel. A chisel for cutting hot metal: distinguished from a Cold chisel. (Standard)

Hot-drawn. A term used to signify the product of drawing, when the operation is performed on material that is hot—usually red hot. (Nat. Tube Co.)

Hothouse. A heated building or chamber for drying pottery or other wares; drying room. (Standard)

Hot roll. To roll while hot, as a metal. (Webster)

Hot saw. A circular saw for cutting hot bar-iron in small pieces. (Standard)

Hot-short. Brittle when heated, especially beyond a red heat, as hot-short iron. (Webster)

Hot spot. A small portion of the furnace shell that is warmer than the rest. It indicates a thin lining. (Willcox)

Houiller. The French equivalent for coal measures. (Roberts)

Hour-glass structure. A structure resembling the shape of an hour-glass seen in thin sections of certain minerals and due to differences of molecular attractions in different directions in a crystal. (Iddings, Rock minerals, p. 72)

House (Eng.). *See* Gunnies and Turnhouse.

House of water (Corn.). A cavity or space filled with water. (Raymond)

Housing. The casing for a machine or part thereof.

Hove (Scot.). Past participle of heave. The floor of a mine working is said to heave or rise. (Barrowman)

Hovel. A large conical or conoidal brick structure, around, or within which the ovens or firing kilns are grouped in the manufacture of porcelain. (Webster)

Howdie horse (No. of Eng.). A pit horse kept on the surface for use in cases of emergency. (Gresley)

Howell. The upper stage in a porcelain furnace. (Standard)

Howell furnace. A form of revolving roasting furnace. (Raymond)

Howk (Scot.). To dig; scoop; make a hollow; to burrow. (Century)

How way! (No. of Eng.). A signal to lower the cage. (Gresley)

Hoya. 1. (Sp.) A hollow or excavation; *H. de carbón*, a coal basin. 2. (Peru) The bed of a river. (Halse)

Hoyo (Sp.). A pit; an excavation. A portion of ore worked with a few laborers. (Halse)

H-piece. That part of a plunger-lift in which the valves or clacks are fixed. (Raymond)

Huacal (Mex.). Crate; bowl; drinking-dipper made of a gourd. (Dwight)

Huachaca (Peru). The portion of ore belonging to the laborer who operated on shares. (Dwight)

Huaillaripa (Peru). Thief of gold ore. (Dwight)

Huaillaripear (Peru). 1. To steal gold ore. 2. To extract gold from tailings by means of sheepskins in a gentle current of water. (Dwight)

Huaira. 1. (Peru) Ancient Indian smelting furnace (still used in Potosi, Bolivia). (Dwight) 2. A ventilating brattice. (Halse)

Huairacañon (Peru). A brattice, generally of wood. (Dwight)

Huairuna (Peru). Small earthen retort, used for retorting amalgam, extracting from 5 pounds to 15 pounds silver from each charge. (Dwight)

Huantajayite. An argentiferous variety of halite, 20 NaCl+AgCl, occurring in cubic crystals and as an incrustation. (Dana)

Huaquero (Peru). An earthenware pitcher found in Indian burial grounds. (Halse)

Huascolite. A variety of galena in which part of the lead is replaced by zinc. (Standard)

Hübnerite. Nearly pure manganese tungstate, $MnWO_4$. When pure it contains 76.6 per cent tungsten trioxide WO_3. (U. S. Geol. Surv.)

Hucica (Panama). High-lying alluvial deposits. (Lucas)

Huckle (Staff. and Derb.). The summit or apex of an anticline or saddle-back. (Page)

Hudge. 1. (Som.) *See* Bowk, 1. Also a small box or tram without wheels, running on timber slides, drawn by a boy, in thin and steep seams. (Gresley)
2. An iron bucket for hoisting ore or coal. (Raymond). *See* Bowk, 2.

Hudsonite. A variety of Cortlandtite. (Kemp)

Hueja (Mex.). A bowl made from a gourd. *See also* Jicara. (Dwight)

Huel (Corn.). A mine; a variant of wheal.

Huella (Mex.). A trace of gold or silver in assaying. (Dwight)

Hueso. 1. (Sp.) Limestone remaining unburnt in a kiln. 2. (Mex.) Wood tin. 3. (Chile) Yellowish compact caliche. 4. (Peru) Bone or argillaceous seams in coal beds. (Halse)

Huevo (Colom.). 1. A name applied to enlargements in ore bodies. 2. A large bowlder of granite or other hard rock in soft country rock. (Halse)

Huff separator. An electrostatic machine depending on the repelling and attracting action of electrically charged particles. The feed is passed over a roller, and the constituents take various electrical charges according to conductivity and are repelled accordingly. (Liddell)

Hugger (No. of Eng.). In coal mining, a back or cleat. (Gresley)

Huingaro (Mex.). Pick, or pick ax. (Halse)

Hule (Sp.). Oil cloth; oil skin. (Halse)

Hulk. 1. (Corn.) To take down and remove the softer part of a lode, before removing the harder part. *See* Gouge, 1, and Dzhu. 2. The removal of the soft gouge. 3. The excavation made by this operation. (Century)

Hulla (Sp.). 1. Pit coal. Black bituminous coal. 2. A generic term for all fossil coal; *H. apizarrada*, slate coal; *H. brillante*, anthracite; *H. de llama*, bituminous coal; *H. grasa*, a coking coal; *H. magna*, noncoking coal; *H. para gas*, gas coal. (Halse)

Hullera (Sp.). 1. A coal mine; a colliery. 2. A coal formation. (Halse)

Humboldtilite. A silicate of aluminum and iron belonging to the melilite group. (Dana)

Humedad (Mex.). Moisture. (Dwight)

Humidity. The condition of being humid; dampness; moisture; as, the humidity of the atmosphere. (Standard)

Humidostat. A device to regulate atmospheric humidity. (Webster)

Huminite. A hydrocarbon from Ostmark, Sweden, having the composition (ash-free): carbon, 67.15; oxygen, 29.83; hydrogen, 2.55; nitrogen, 0.47; and sulphur, 0.40 per cent. (Bacon)

Humite. A basic fluo-silicate of magnesium. Orthorhombic. Fracture subconchoidal to uneven. Brittle. Luster vitreous to resinous. Color white, light-yellow, honey-yellow to chestnut-brown and garnet, or hyacinth-red. (Dana)

Hummock. 1. A small elevation; hillock. 2. A pile or ridge of ice on an ice-field. (Standard)

Hummocky. Lumpy, or in small uneven knolls. (Roy. Com.)

Humo (Sp.). Fume; smokedamp, or damps in a mine. (Halse)

Hump (Aust.). A long tramp with a bundle on one's back, as a *hump* of 50 miles. (Webster)

Humpe (Peru). Carbon dioxide gas in mines; choke damp. (Halse)

Humphed coal (Scot.). Coal altered by contact with an igneous rock; inferior coal. (Barrowman)

Humus. A dark brown substance, formed usually in the soil, due to the partial decomposition of vegetal matter; the organic portion of the soil. (Webster)

Hund (Pr.). A dog. A rectangular iron tram or wagon on four small wheels. (Gresley)

Hundido (Sp.). Cave or run. *See* Derrumbe. (Halse)

Hundimiento (Sp.). 1. A cave or run of ground; fall of roof. 2. Letting down the roof, as in longwall working. Subsidence. (Halse)

Hundred-weight. A weight commonly reckoned in the United States, and for many articles in England, at 100 pounds avoirdupois; but commonly in England, and formerly in the United States, at 112. There is also an older hundredweight, called the *long hundredweight*, of 120 or six-score pounds. (Standard)

Hungarian mill. A rotating, grinding mill used in Hungary for removing small portions of gold from quartz by mixing with mercury: one of the many forms of pan-amalgamators. (Standard)

Húngaro (Peru). A roasting furnace with two beds, one above the other. (Halse)

Hungry. Hard, barren vein matter, as white quartz. *Compare* Likely. (Hanks)

Hung shot. A shot which does not explode immediately upon detonation or ignition (C. and M. M. P.). *See also* Hangfire.

Hunker. 1. (India) Yellowish clay containing concretionary nodules. (Gresley)
2. Eng.) To sit with the balls of the feet upon the ground and the knees bent, so that the thighs rest on the calves of the legs. This position no doubt became habitual with miners from the nature of their underground work. (G. C. Greenwell)

Hunt continuous filter. A horizontally-revolving continuous-vacuum filter. It consists of an annular filter bed, usually of triangular wooden slats filled with coarse sands. The vacuum withdraws part of the pulp moisture as soon as the bed is formed. A spray then washes it after which the vacuum dries it and the material is then scraped off. (Liddell)

Hunt and Douglas process. Consists in roasting matte carrying copper, lead, gold, and silver at a very low temperature, forming copper sulphate and oxide but not silver sulphate. This product is leached with dilute sulphuric acid for copper. The resulting solution is treated with calcium chloride and the copper precipitated as subchloride by passing SO_2 through the solution. The cuprous chloride is then reduced to cuprous oxide by milk of lime, regenerating calcium chloride, and the cuprous oxide is smelted. (Liddell)

Huntilite. A silver arsenide occurring with native silver at Silver Islet, Lake Superior, Michigan. (Century)

Hunting coal (York.). Ribs and posts of coal left for second working. (Gresley)

Huntington and Heberlein process. *See* Blast-roasting.

Huntington mill. A mill of the Chilean type operating by the centrifugal force of steel rollers revolving against the inner surface of a heavy horizontal steel ring or die. The rollers are suspended upon rods from horizontal arms by short trunnions allowing a swing of the rod and roller in a direction radial from the central vertical shaft. (Liddell)

Hunt's process. Originated by Bertram Hunt for treating precious metal ores containing copper or zinc, using an ammoniacal cyanide solution and recovering ammonia by boiling. The process may more truly be said to have been devised and perfected by Mosher. (Liddell)

Hurdled ore. Ore passed through a coarse screen, like a mortar screen. (Davies)

Hurdle screen (Scot.). A temporary screen or curtain for clearing gas out of a pit (Gresley). Used especially where gas has collected in pot holes or caves in the roof.

Hurdy-gurdy. 1. *See* Hurdy-gurdy wheel. 2. A dance house in a mining camp. (Standard)

Hurdy-gurdy drill (Aust.). A hand auger used for boring holes in coal. (Power)

Hurdy-gurdy wheel. A water wheel operated by the direct impact of a stream upon its radially-placed paddles. (Raymond)

Hurgón (Sp.). A poker; *H. de punta curva*, a rabble. (Halse)

Hurlbarrow (Scot.). A wheelbarrow. (Standard)

Hurler (Scot.). One who wheels bricks or heavy material on a wheelbarrow. (Standard)

Hurley (Scot.). A box on wheels; a hutch. (Barrowman)

Huronian. In geology, in the usage of the U. S. Geological Survey, the lower of the two series comprised in the Algonkian system. Also the corresponding geologic epoch. By some geologists the Huronian is divided into Lower Huronian, Middle Huronian, and Upper Huronian or Animikean. (La Forge)

Hurrier. *See* Haulier. Generally a small boy who trams coal. (Gresley)

Hurry. 1. To haul, pull, or push cars of coal, in a mine. (Gresley) 2. (Scot.) A screen or sieve. 3. A chute, slide or pass as for ore in a mine, or for coal discharged from cars into vessels. (Webster) 4. (Gt. Brit.) A wooden staging on a navigable river, to which the railways are conducted from coal pits: used in loading vessels with coal. (Standard)

Hurry gum (Scot.). The fine material that passes through a screen or sieve. (Barrowman)

Hush (Gt. Brit.). To clear away (soil) from bedrock in prospecting. (Standard)

Hushing. The discovery of veins by the accumulation and sudden discharge of water, which washes away the surface soil and lays bare the rock. *See also* Booming. (Raymond)

Husky. An Eskimo dog (Webster). Used extensively in traveling and freighting in the far north.

Hutch. 1. (Scot.) A low car, suited both to run in a level and to be hoisted on a cage. 2. (Corn.) A cistern or box for washing ore. *See also* Jig, 1. (Raymond) 3. To wash ore in a box or jig. (Webster) 4. (Scot.) A basket for coal. 5. (Scot.) Two hundredweight of pyrite. (Standard) 6. The fine concentrates which pass through a jig screen.

Hutch cleading (Scot.). The wood comprising the bottom, side, and end boards of a hutch. (Barrowman)

Hutch mounting (Scot.). The ironwork on the frame and box of a wooden hutch. (Barrowman)

Hutch road (Scot.). A hutch tramway. (Barrowman)

Hutch runner (Scot.). A boy who draws hutches. (Gresley)

Hüttenwerk (Ger.). A furnace or smelting house. (Davies)

Huttrill. A hard place in a vein or pipe. (Hooson)

Hyacinth. A transparent red, or brownish, variety of zircon, sometimes used as a gem. (Dana)

Hyaline. A synonym for glassy, which is often prefixed to the name of volcanic rocks to signify a glassy development, as hyalo-rhyolites. (Kemp)

Hyaline quartz. Quartz with a bluish, opalescent, cast due to presence of chalcedony. Used as a gem. (Standard)

Hyalite. A variety of opal (hydrous silica) which occurs in clear globular or botryoidal forms resembling drops of melted glass. (U. S. Geol. Surv.)

Hyalithe. An opaque variety of glass, frequently black, green, brown, red, etc., resembling porcelain, and valuable owing to its strength. (Standard)

Hyalography. The art of engraving on glass, either with a diamond, emery, or hydrofluoric acid. (Standard)

Hyalomelane. Basaltic glass. The word is derived from the Greek for black glass. (Kemp)

Hyalophane. A barium feldspar, $(K_2,Ba)Al_2(SiO_3)_4$. In crystals; also massive. Monoclinic. Switzerland and Sweden. (Dana)

Hyalopilitic. Composed of, or characterized by, innumerable slender microlites embedded in glass; a structure frequently found in basaltic lavas. (Webster)

Hyalosiderite. A highly ferruginous variety of common olivine. (Dana)

Hybrid porcelain. A ware originally made in imitation of oriental porcelain, containing some kaolin; essentially an artificial, soft porcelain, represented by the early Italian and French porcelains. (Standard)

Hydato. A prefix to lithological terms to indicate an origin through aqueous processes. (Kemp)

Hydatogenic. In geology, derived from or modified by substances in a liquid condition: said of the genesis of ores and other minerals: contrasted with Pneumatogenic. (Standard)

Hydatopneumatic. Pertaining to, or formed by, the combined action of gas and water. (Webster)

Hydatopneumatolytic. A term used in the discussion of certain ore deposits to describe their origin through the agency of water and vapors. (Kemp)

Hyde process. A flotation process patented in 1911, by James M. Hyde, in which a small amount of sulphuric acid, with or without the use of copperas, is used to give the slimy portion of the ore a preliminary coagulation before flotation. The sulphides, after agitation, are floated off rapidly and as completely as possible with a considerable overflow of freely flowing water, thereby producing an impure concentrate which is re-treated in a second machine. (Liddell)

Hydrargillite. A synonym for Gibbsite.

Hydrargyriasis. Chronic mercurial poisoning. (Webster)

Hydrargyrum. Mercury. (Webster)

Hydrate. 1. A compound formed by the union of water with some other substance and represented as actually containing water. 2. Less properly, a hydroxide, as calcium hydrate. (Webster)

Hydrated. Containing water in chemical combination, and hence in a definite proportion in each case, as gypsum which contains 'water of crystallization,' calcium hydrate, or lime which has absorbed water on slaking, hydrated oxide of iron, or yellow ocher, which can be readily converted into the anhydrous or red oxide by driving off the water by heat. (Roy. Com.)

Hydraulic. 1. Of or pertaining to fluids in motion; conveying, or acting, by water; operated or moved by means of water, as hydraulic mining. 2. Hardening or setting under water, as hydraulic cement. (Webster)

Hydraulic cartridge. A device used in mining to split coal, rock, etc., having 8 to 12 small hydraulic rams in the sides of a steel cylinder. (Webster)

Hydraulic cement. Cement which sets under water. The rocks, which on being calcined and ground very fine yield this cement, must contain in addition to lime certain proportions of alumina, silica and magnesia. A little iron is also usually present. (Roy. Com.)

Hydraulic dredge. A dredge in which the material to be excavated is mixed with water and pumped through a pipe line to the place of deposit. (Webster)

Hydraulic elevator. An elevator operated by the weight or pressure of water, especially an apparatus used in dredging and hydraulic mining which raises mud and gravel by means of a jet of water under heavy pressure inducing a strong upward current through the pipe. (Webster)

Hydraulic gradient. A line showing the fall in pressure of water or other liquid in passing through a pipe discharging at one end. (Webster)

Hydraulic hose. The flexible hose used to direct a stream of water against a wall or face of drift. (Davies)

Hydraulic jack. A jack for lifting, pressing, etc., in which pressure on the moving part is transmitted by a liquid, as water or oil.

Hydraulicity. The property of hardening under water; said of materials for hydraulic cement. (Standard)

Hydraulicking (Pac.). Washing down a bank of earth or gravel by the use of pipes, conveying water under high pressure. (Raymond)

Hydraulic lime. A variety of calcined limestone which, when pulverized, absorbs water without swelling or heating, and affords a paste or cement that hardens under water. (Standard)

Hydraulic limestone. A limestone which contains some silica and alumina, and which yields a quicklime that will set or form a firm, strong mass under water, as in hydraulic cements. (Dana)

Hydraulic mine-filling. Filling a mine with material transported by water. (Charles Enzian, Bull. 60, U. S. Bur. Mines)

Hydraulic mining. A method of mining in which a bank of gold-bearing earth or gravel is washed away by a powerful jet of water and carried into sluices, where the gold separates from the earth by its specific gravity (Standard). (Woodruff *v.* North Bloomfield Grand Mining Co., 18 Fed. Rept., p. 756.) Also used for other ores, earth, anthracite culm, etc. Hydraulic mining is made unlawful and prohibited in certain river systems where it obstructs navigation and injures adjoining landowners. (United States *v.* North Bloomfield Gravel Mining Co., 81 Fed. Rept., p. 249.) (U. S. Min. Stat., p. 934, 941–943)

Hydraulic mortar. Mortar that will harden under water (Standard). *Compare* Hydraulic cement.

Hydraulic ram. A machine for raising water by the energy of the moving water of which a portion is to be raised. (Webster)

Hydraulics. That branch of science or of engineering which treats of water or other fluid in motion, its action in rivers and canals, the works and machinery for conducting or raising it, its use in driving machinery, etc. (Webster)

Hydroapatite. A milk-white hydrous variety of apatite. (Standard)

Hydrocarbon. A compound containing only hydrogen and carbon. The simplest hydrocarbons are gases at ordinary temperatures; with increase in molecular weight they change to the liquid, and finally to the solid state. (Webster)

Hydrocarbon black. A synonym for Lampblack. (Bacon)

Hydroceramic. Describing porous pottery through which water exudes and causes coolness by evaporation. (Standard)

Hydroclastic. Clastic through the agency of water; said of fragmental rocks deposited by water. (Webster)

Hydrocyanic acid. An unstable, volatile, colorless, and extremely poisonous liquid compound, HCN, formed by decomposing metallic cyanides with hydrochloric acid. It has a characteristic odor resembling that of bitter almonds. Called also Prussic acid. (Standard)

Hydrodynamic. Of or pertaining to hydrodynamics; relating to the force or pressure of water or other fluids. (Standard)

Hydrodynamometer. An instrument for determining the velocity of a fluid in motion by its pressure. (Standard)

Hydrofluoric acid. A volatile, colorless, hygroscopic corrosive liquid compound, HF, formed by decomposing metallic fluorides. It readily attacks silica, and is largely used for etching on glass. (Standard)

Hydrofranklinite. *See* Chalcophanite.

Hydrogen. A gaseous element, colorless, odorless, tasteless, inflammable, and lighter than any other known substance. Symbol, H; atomic weight, 1.01; specific gravity, 0.07. (Webster)

Hydrogenous. Formed or produced by water; applied to rocks formed by the action of water, in contradistinction to pyrogenous rocks, or those formed by the action of heat. (Century)

Hydrogenous coal (Aust.). Coals containing a large quantity of moisture, *e. g.*, brown coal. (Power)

Hydrohematite. *See* Turgite.

Hydrology. That part of geological science which has to do with the relations of water standing or flowing beneath the surface of the earth.

Hydrolysis. A chemical decomposition by which a compound is broken up and resolved into other compounds by taking up the elements of water. (Century)

Hydromagnesite. A white, hydrous, magnesium carbonate that is earthy and chalklike. (Century)

Hydromechanics. The mechanics of fluids, including hydrostatics, hydrodynamics, hydrokinetics, and pneumatics. (Standard)

Hydrometallurgy. The reduction of ores by wet processes, as by leaching and precipitation.

Hydrometamorphism. Metamorphism, as of rocks, produced by water and heat: contrasted with Pyrometamorphism. (Standard)

Hydrometer. A floating instrument for determining the specific gravity of liquids. (Webster)

Hydrophane. A variety of common opal which becomes more translucent or transparent in water. (Dana)

Hydrophilic. A property possessed by colloids whereby they take up water in conjunction with the molecules of the colloid in a manner analogous to a closed hydrated molecule. Hydrophilic colloids are valuable dispersing mediums for the making of emulsions. (Rickard) A term used in flotation processes.

Hydrophilite. Chlorocalcite. Calcium chloride, $CaCl_2$. In white cubic crystals or as an incrustation at Vesuvius. (Dana)

Hydroplutonic. Relating to or produced by the joint action of heat and water, resulting in fusion at a lower temperature than by heat alone; aqueo-igneous. (Standard)

Hydropneumatic. Relating to, or produced, or worked by the combined action of water and air, or gas. (Standard)

Hydroscope. An instrument for detecting moisture, especially in the air. (Standard)

Hydrosphere. 1. The aqueous vapor of the entire atmosphere. 2. The aqueous envelope of the earth, including the ocean, all lakes, streams, and underground waters and the aqueous vapor in the atmosphere. (Webster)

Hydrostat. A contrivance or apparatus to prevent the explosion of steam boilers. (Webster)

Hydrostatic balance. A balance for weighing substances in water to ascertain their specific gravity. (Webster)

Hydrostatic pressure. The pressure exerted by a liquid, as water, at rest. (Standard)

Hydrostatics. That branch of physics which relates to the pressure and equilibrium of liquids, as water, mercury, etc.; the principles of statics applied to water and other liquids. (Webster)

Hydrotasimeter. An electrically operated apparatus showing at a distance the exact level of water, as in a reservoir; an electric high- and low-water indicator. (Standard)

Hydrothermal. Pertaining to hot water, especially with respect to its action in dissolving, re-depositing, and otherwise producing mineral changes within the crust of the globe. (Power)

Hydrous. Containing water chemically combined, as in hydrates and hydroxides. (Webster)

Hydrous salts. Salts containing the so-called water of crystallization.

Hydroxide. A compound of an element with the radical or ion, OH, as sodium hydroxide, NaOH.

Hydrozincite. A basic zinc carbonate, perhaps $ZnCO_3.2Zn(OH)_2$. Massive, fibrous, earthy or compact, as incrustations. Color white, grayish or yellowish. Occurs at mines of zinc, as a result of alteration (Dana). Also called Zinc bloom.

Hygrometer. An instrument or apparatus for measuring the degree of moisture of the atmosphere. (Webster)

Hygroscopic. Having the property of readily absorbing moisture from the atmosphere. (Power)

Hypabyssal. Having become consolidated from fusion, underground, under conditions intermediate between deep-seated and superficial conditions, and therefore differentiated by special structural features; said of certain igneous rocks, sometimes called dike-rocks. (Standard)

Hypautomorphic. In petrology, same as Hypidiomorphic and Subhedral. (La Forge)

Hyperite. Used in Sweden loosely for the rocks of the gabbro family, and in a restricted sense for olivine-norite. (Kemp)

Hyperphoric. Change in a rock by the introduction of a new mineral into, or the removal wholly or in part of an old mineral from the original rock mass, for example, dolomitization of limestone. (Power)

Hypersthene. An orthorhombic pyroxene, $(Fe,Mg)SiO_3$. (Dana)

Hypersthenite. An obsolete name for Norite. (Kemp)

Hypidiomorphic. In petrology, same as Subhedral, which *see*. (La Forge)

Hypocrystalline. In petrology, partly crystalline; said of the texture of some igneous rocks which consist partly of crystallized minerals and partly of amorphous glass; hypohyaline. (La Forge)

Hypogeic. Pertaining to or derived from crustal and interior movements in the earth; as, the *hypogeic* work of mountain making. (Standard)

Hypogene. 1. A term proposed by Lyell for all nether-formed rocks, *i. e.* rocks that have assumed their present form at great depths beneath the surface, whether originally stratified or unstratified. The former belong to the metamorphic and the latter to the plutonic group. (Roy. Com.)
2. Applied to ores or ore minerals that have been formed by generally ascending waters as contrasted with supergene ores or minerals (Ransome). *Compare* Supergene.

Hypohyaline. Partly glassy. *See* Hypocrystalline. (Iddings, Igneous rocks, p. 187)

Hypsometer. An instrument for measuring the height above the sea level by determining the atmospheric pressure through observation of the boiling point of water. (Standard)

Hysteresis. 1. In physics, a lagging or retardation of the effect, when the forces acting upon a body are changed as if from viscosity or internal friction. 2. In a magnetic material, as iron, a lagging in the values of resulting magnetization due to a changing magnetizing force. (Webster)

Hysterobase. A name given by K. A. Lassen to the rock of a series of dikes, related to the diabases, but differing from them, in often having quartz, brown biotite, and brown hornblende, the last sometimes replacing the augite. There may be also some glass basis. (Kemp)

Hysterogenite. Posepny's term for mineral deposits derived from the débris of other rocks. The word means of secondary or later formation. *Compare* Idiogenite, Xenogenite. (Kemp)

Hysteromorphous. Applied to secondary deposits due to surface agencies. (Power)

I.

Ice age. The glacial period. (Webster)

Iceberg. A large floating mass of ice, detached from a glacier. (Webster)

Ice blink (Greenland). A cliff of ice on a coast (Webster). *See* Ice cliff.

Ice bowlder. A bowlder transported and deposited through glacial action. (Standard)

Ice cap. A perennial mantle of ice and snow covering a tract and moving in all directions from the center. A very large ice cap is an ice sheet, or continental glacier. (Webster)

Ice cliff. An abrupt shore of arctic ice, more or less interstratified and covered by earth and vegetation (Standard). *See* Ice blink.

Ice creeper. A creeper, used for walking on ice. (Webster)

Ice drift. Loose floating ice. (Standard)

Ice fall. 1. A frozen waterfall, or a similar mass of ice. 2. A falling of ice as from an iceberg. (Webster)

Ice field. A large field of floating ice (Standard). *See also* Ice float.

Ice float; Ice floe. A sheet, or flat free mass, of floating ice (Webster). *See also* Ice field.

Ice foot. A wall of ice formed by sea water and snow frozen at the seashore in polar regions. Also called Ice ledge. (Standard)

Iceland agate. A name for obsidian from Iceland. (Chester)

Iceland spar. Transparent calcite, which, owing to its strong double refraction, is largely used for optical purposes. Also called Iceland crystal. (Standard)

Ice ledge. *See* Ice foot.

Ice mark. Any mark or indication left by moving ice or glacial action. (Standard)

Ice mill. The place where a glacier abrades underlying rock through the action of rubble. (Standard)

Ice mountain. An iceberg. (Standard)

Ice pack. A large area of floating pieces of ice driven together more or less closely. (Webster)

Ice pillar. A pedestal of ice on a glacier, supporting a broader block of stone, which has protected the ice beneath it from solar heat. (Standard)

Ice pyramid. A mound of ice on a glacier, having a stone or earthy débris lying against its foot. (Standard)

Ice quake. The crash, or concussion, attending the breaking up of masses of ice, often due to contraction from extreme cold. (Webster)

Ice river. A glacier (Standard). *See also* Ice stream.

Ice spar. Sanidine; a white transparent variety of orthoclase. (Power)

Ice stream. A glacier; also a collection of floes moving in a certain course (Webster). An ice river.

Ice system. A system of glaciers diverging from a common center. (Standard)

Ice table. A mass of level ice. (Standard)

Ice ton. The theoretical number of heat units required to melt one ton of ice at 32° F. It is 284,000 B. T. U., taking the ton at 2,000 pounds, or 318,080 B. T. U. for a ton of 2,240 pounds. (Webster)

Ice tongue. A steep, narrow cliff of ice, rising high above glacial névé, and extending upward toward the higher mountain peaks. (Standard)

Ice wall. *See* Ice foot.

Ice worn. Abraded by ice; specifically, rubbed, scratched, or channeled by glacial action. (Standard)

Ichnite. A fossil footprint. (Webster)

Ichnolite. A fossil footprint or the stone containing it. (Standard)

Ichnology. The science which treats of the footprints of extinct animals. (Emmons)

Icosinene. A liquid hydrocarbon ($C_{20}H_{38}$) contained in ozocerite. (Standard)

I. D. B. (Africa) Illicit diamond buyer. (Morrison)

Ideal form. A crystal form in which like faces are of the same size and shape. (A. F. Rogers)

Idiogenites. A term suggested by Posepny to describe those ore deposits which are contemporaneous in origin with the wall rock. The word means of the same origin. *Compare* Xenogenite, Hysterogenite. (Kemp)

Idiogenous. Said of deposits contemporaneous in origin with the rocks in which they occur, *i. e.*, primary deposits which are constituents of the rocks in which they occur. (Power)

Idiomorphic. In petrology, bounded by the crystal faces proper to itself; euhedral; automorphic: said of some crystals in an igneous rock and opposed to Allotriomorphic. (La Forge)

Idiophanous. Exhibiting interference figures in crystals without the aid of the polariscope. (Webster)

Idler. A sheave or pulley running loose on a shaft to guide or support a rope. (C. M. P.)

Idle wheel. A pulley to guide a driving belt, to increase its tension, or to increase its arc of contact on one of the working pulleys. (Standard)

Idocrase. *See* Vesuvianite.

Idria furnace. *See* Leopoldi furnace.

Idrialite. A dark earthy mineral, consisting of hydrocarbons, mixed with cinnabar, clay, etc., It occurs in Idria, Austria. (Webster)

Idryl. A black material obtained from the mercury condensation-chambers at Idria, which Bödeker considered as the radical of idrialite. (Bacon)

Igneo (Sp.). Igneous. (Dwight)

Igneo-aqueous. Formed by the joint action of fire and water. Thus ashes thrown from a volcano into water and there deposited in a stratified form might properly be said to be of igneo-aqueous origin. (Century)

Igneous. In petrology, formed by solidification from a molten state: said of the rocks of one of the two great classes into which all rocks are divided, and contrasted with Sedimentary (La Forge). Rocks formed in this manner have also been called plutonic rocks, and are often divided for convenience into *plutonic* and *volcanic* rocks, but there is no clear line between the two. (Webster)

Igneous fusion. Fusion unassisted by the solution in the water of crystallization as in the case of anhydrous substances. Opposed to aqueous fusion. (Webster)

Ignescent. A stone or mineral that gives out sparks when struck with steel or iron. (Standard)

Igniter. 1. A metal case containing an ordinary fuse at one end with a number of instantaneous fuses branching out from the other end and leading to as many holes to ignite blasting charges. (Webster)
2. A device to relight safety lamps internally by friction. One type uses a waxed strip with igniting matches at intervals, while another type has a small burred wheel operating against a piece of cerium or something of a similar nature. Electrical devices are sometimes employed.

Ignites. A word used by M. E. Wadsworth to include all pyrotechnic minerals. (Power)

Ignition. 1. The act of igniting, or the state of being ignited. 2. Percussion material or detonating powder. (Standard)

Ignition charge. A small charge of black or other easily ignited powder, used with the main charge of smokeless or other slow-igniting powder to receive ignition from the primer, thus expediting the main charge. (Webster)

Ignition tube. A small, hard glass tube for examining the behavior of substances when heated. (Webster)

Ijadas (Mex.). 1. An assay; samples of two to five pounds. 2. An early term (1565) for jade. (Halse)

Ijolite. A granitoid, nephelite rock, occurring in Finland and corresponding in mineralogy to the nephelinites. It contains chiefly nephelite and pyroxene. The name is derived from the Iijoki river, Finland, and was given by Ramsay and Berghell. (Kemp)

Ilesite. A hydrous sulphate of manganese, zinc, and iron found in friable crystalline aggregate in Park County, Colorado. (Century)

Ill air (Scot.). Noxious gas, as from underground fires or choke damp; a stagnant state of the atmosphere underground. (Barrowman)

Illinition. A thin crust of extraneous matter formed on minerals. (Standard)

Illiquation. The melting of one substance into another. (Standard)

Ilmenite; Menaccanite. Iron-titanium oxide, $FeTiO_3$. Contains 36.8 per cent iron and 31.6 per cent titanium (52.7 per cent TiO_2) (U. S. Geol. Surv.). Is sometimes prefixed to those rocks which contain enough of the mineral to receive attention as ores; thus ilmenite-gabbro, ilmenite-norite, etc. (Kemp)

Ilvaite; Lievrite; Yenite. A mineral, $CaFe_2(FeOH)(SiO_4)_2$, occurring in prisms, with prismatic faces vertically striated. Columnar or compact massive. Fracture uneven. Brittle. Luster submetallic. Color iron-black or dark grayish black. Streak black, inclining to green or brown. Opaque. (Dana)

Imán (Sp.). Magnet; *Piedra imán*, lodestone. (Dwight)

Imbibición (Sp.). Desilverizing rich ores, lead matte, etc., in a bath of molten lead. (Halse)

Imbrex. 1. A curved tile; a pantile. 2. One of the scales or partitions of overlapping tilework or of other imbrication. (Standard)

Imbricate structure. *See* Distributive fault.

Imlay table. *See* End-bump table.

Immersed bog. In geology, a bog which increases by various plant-accumulations and growths under water (Standard). *Compare* Emerged bog.

Impact screen. A type in which the screen moves with the load of material, bringing up against a stop so as to throw the material forward on it. The Imperial screen is a common type. (Liddell)

Impalpable. Extremely fine, so that no grit can be perceived by touch. (Webster)

Impastation. 1. In ceramics, the act or process of converting into paste. 2. A combination of different materials baked together or united by a cement: said of porcelain, etc. (Standard)

Imperial screen. An oscillating or vibrating screen on which the ore is thrown upward, as well as moved forward on the screen. (Liddell)

Imperial yellow porcelain. A Chinese hard porcelain having a uniform yellow glaze, originally made exclusively for the imperial family and others connected with the court. (Standard)

Impervious. Impassable; applied to strata such as clays, shales, etc., which will not permit of the penetration of water, petroleum or natural gas. (Roy. Com.)

Impervious bed. A bed or stratum through which water will not move under ordinary hydrostatic pressure. (Meinzer)

Implosion. A bursting inward; sudden collapse; opposed to *explosion*. (Standard)

Impound. 1. To collect (water) as by damming a stream for irrigation purposes, or the like. 2. A reservoir for water, as one made by damming a stream (Webster). Used in connection with the storage of tailings from ore-dressing plants and hydraulic mines.

Impregnated. Containing metallic minerals, scattered or diffused through the mass. Properly used in referring to country rock containing mineral similar to that in the vein. (Weed)

Impregnation. An ore deposit consisting of the country-rock impregnated with ore, usually without definite boundaries. (Raymond)

Improvement. As used in the mining statutes, is an artificial change of the physical condition of the earth upon or reasonably near a mining claim as to evidence a design to discover mineral therein, or to facilitate its extraction. It must be reasonably permanent in character (Frederick *v.* Klauser, 52 Oregon, p. 116). *See also* Labor and improvement.

Impsonite. An asphalt found in Oklahoma much like albertite but almost insoluble in turpentine. (U. S. Geol. Surv.)

Impuesto minero (Mex.). The tax paid on mining claims. (Dwight)

Impulse. A force communicated suddenly; the effect of an impelling force; a thrust; a push. (Century)

In (Eng.). When a stall or other working place in a mine is blocked up with fallen roof, etc., it is said to be *in*, or to have come in. (Gresley)

Inalterable. Unaffected by the action of light or air: applied to painted porcelain, faience, or enamel, the colors of which have been fired. (Standard)

Inaurate. Having a golden luster. (Standard)

Inbond. Laid with its length across the thickness of a wall: said of a brick or of a long stone. (Standard)

Inby; Inbye; Inbyeside (Newc.). Toward the working face, or interior, of the mine. Away from the shaft or entrance. Also called In-over.

Incandescent. Made luminous by heat; white or glowing with heat. (Standard)

Inches of pressure. The height in inches of a column (1) of water, or (2) of mercury, as a measure of hydrostatic pressure. (Standard)

Inch-pound. A unit of work, being the work done by raising one pound through an inch. (Century)

Incinerate. To burn to ashes; to consume by fire; to cremate. (Webster)

Incinerator. A furnace or oven for incinerating substances, as refuse. (Webster)

Incised ware. Pottery decorated with scratches; graffito. (Standard)

Inclinación (Sp.). Hade; dip; inclination; slope. (Lucas)

Inclination. The *dip* of a vein measured from the horizontal. (Skinner)

Incline. 1. A shaft not vertical; usually on the dip of a vein. *See also* Slope. (Raymond)
2. Any inclined plane, whether above or beneath the surface. Usually applied to self-acting planes above ground, as in the bituminous coal fields. (Steel)

Incline bogie (Scot.). A wheeled carriage for inclines, constructed with a horizontal platform so that cars can be run on it and be conveyed up and down the incline or slope. (Barrowman)

Inclined cut-and-filling. *See* Rill stoping.

Inclined plane. A natural or artificial slope used for facilitating the ascent, descent or transfer from one level to another of vehicles or other objects (Standard). *See also* Incline, 2.

Inclined shaft. *See* Incline, 1.

Inclinometer. 1. A dipping compass. 2. An instrument for measuring inclination or slope, as of the ground or of an embankment; clinometer. (Standard)

Inclusion. 1. In petrology, a crystal or fragment of another substance; or a minute cavity, filled with gas or liquid, inclosed in a crystal. 2. A fragment, of whatever size, of another rock inclosed in an igneous rock; a xenolith. (La Forge)

Incompetent. In geology, not combining sufficient firmness and flexibility to transmit a thrust and to lift a load by bending; consequently, admitting only the deformation of flowage: said of strata and rock structure. *See also* Competent, 1. (Standard)

Incorporadero (Mex.). The place where the *incorporo*, in the patio process, is effected. (Dwight)

Incorporar (Sp.). In amalgamation, to add the first charge of quicksilver. The term *cebar* is applied to the adding of subsequent charges; it also means the act of thoroughly mixing the quicksilver, with *torta* of wet ore. (Min. Jour.)

Incorporo (Mex.). The adding and mixing of mercury and other ingredients for the *patio* process. (Dwight)

Incrustation. 1. A crust or hard coating of anything upon or within a body, as a deposit of lime inside a steam boiler. (Webster)
2. A method of ornament that consists in applying or in inlaying one (usually a finer) material upon another, as colored marbles, mosaics, lacquers, or enamels upon wood, stone, or metal; also the material so applied. (Standard)

Indagación (Sp.). Search; examination. (Halse)

Index fossil. A genus or species of fossil which is peculiar to, or characteristic of, a geological horizon or zone. (Webster)

Index of refraction. A number which expresses the ratio of the sine of the angle of incidence to the sine of the angle of refraction. (Webster)

Index plane. A surface of any bed, dike, or vein, which may be regarded as a plane and used as a base for measurement of fault movements. (Farrell)

India. A remarkably fast-cutting, long-wearing oilstone made from alundum. (Pike)

India-cut. In lapidary work, a cut approximately in the form of a brilliant, but done in such a way as to retain as much weight as possible. India-cut stones are clumsy and are usually recut for Western markets. (Webster)

Indiana furnace. A simple Belgian zinc furnace in which the gas is fired under the lowest row of retorts. (Ingalls, p. 474)

Indianaite. A kind of white clay from Lawrence County, Indiana, used in making porcelain. (Century)

Indianite. A variety of anorthite occurring as the gangue of corundum at the Carnatic, India. (Century)

Indian ocher. A native Indian red, principally of Fe_2O_3.

Indian pipestone. *See* Catlinite.

India steel. A fine natural steel from southern India made direct from the ore; wootz. (Standard)

Indicated horsepower. That horsepower which is calculated from indicator-diagrams, as distinguished both from that which is measured by a dynamometer and from nominal horsepower. (Standard)

Indicated power. *See* Indicated horsepower.

Indicator. 1. An instrument for showing at any moment the position of the cage in the shaft. 2. An instrument for recording, by a diagram, upon a card the varying pressure of the steam in the cylinder of a steam-engine during the stroke. (Raymond)
3. An apparatus for showing the presence of firedamp in mines, the temperature of goaves, the speed of a ventilator. (Steel)
4. (Aust.) One of a group of narrow pyritiferous seams, the intersections of which with the auriferous quartz veins of the district are usually characterized by rich accumulations of gold. 5. A substance used in chemistry to indicate to the eye, usually by its capacity for color change, the condition of a solution as to the presence of free acid, alkali, or other substance. (Webster)

Indicator card, or diagram. A diagram showing the variation of steam pressure in the cylinder of an engine during an entire stroke or revolution. (C. and M. M. P.)

Indicator vein. A vein which is not metalliferous itself, but, if followed, leads to ore deposits (Duryee). *See also* Indicator, 4.

Indicolite. An indigo-blue variety of tourmaline. (Dana)

Indigo copper. Covellite. (Dana)

Indium. A soft, white, malleable, and easily fusible metallic element found combined, in very small quantities, in many ores, especially zinc blende. Symbol, In; atomic weight. 114.8; specific gravity 7.2. (Webster)

Individual coal car. One owned or leased by a coal operator, and not by the transportation company. These cars have painted on their sides the names, initials, or some chosen trade-mark or emblem of their owners, and are run for their exclusive benefit. They are generally used between the mines and the coastwise shipping ports of the various railroads. (Nicolls)

Indoor (Eng.). Toward the inside of a cylinder; as, the *indoor* stroke of a piston (Standard). *See also* Indoor stroke.

Indoor catches. Strong beams in a Cornish pump, to catch the walking beam in case of accident and prevent damage to the engine itself. (Gresley)

Indoor stroke (Eng.). That stroke of a Cornish pump which lifts the water at the bottom or drawing lift. (Gresley)

Indraft; Indraught. The act of drawing in, or that which is drawn in; an inward suction or flow; as, an *indraft* of air. (Standard)

Induction. The production of magnetization or electrification in a body by the mere proximity of magnetized or electrified bodies, or of an electric current in a conductor by the variation of the magnetic field in its vicinity. (Standard)

Induction balance. An apparatus for measuring changes of conductivity, detecting the proximity of metallic bodies, etc., by noting extremely minute changes in an electric current. (Standard)

Induction coil. An apparatus for generating currents by electromagnetic induction. (Standard)

Induction-pipe, -port, or -valve. The pipe, port or valve through which the live steam or other motive fluid passes to the cylinder of an engine. (Standard)

Indurated. Hardened; applied to rocks hardened by heat, pressure, or the addition of some ingredient not commonly contained in the rock referred to, as, marls indurated by calcium carbonate. (Roy. Com.)

Indurated talc. An impure, hard, slaty variety of talc (Standard). Called also Talc slate

Infection. Communication of disease, as by contact or through the medium of air, water, or clothing: distinguished from *contagion* (Standard). Important in accident and first-aid work.

Infilling. Material used for filling in; filling. (Standard)

Infiltration. 1. The deposition of mineral matter among the grains or pores of a rock by the permeation or percolation of water carrying it in solution. (Roy. Com.)
2. The material filling a vein as though deposited from a solution in water. (Standard)

Infiltration theory. The theory that a vein was filled by the infiltration of mineral solutions. (Raymond)

Infiltration vein. A vein that has been filled by percolation of hot solutions, often alkaline, laterally or from below. (Standard)

Inflammable. Readily inflamed, in any sense; easily set on fire; as, an *inflammable* gas. (Standard)

Influent stream. A stream whose upper surface stands higher than the water table in the locality through which it flows, and which is not separated from the water table by any impervious bed. (Meinzer)

In fork (Eng.). When pumps are working after the water has receded below some of the holes of the windbore, they are said to be *in fork*. (Gresley)

Informe (Mex.). Report. (Dwight)

Infraglacial. Pertaining to, derived from, or caused by processes taking place under, or at the bottom of, glaciers or glacial sheets; sub-glacial. (Standard)

Infragranitic. Situated or derived from sources below granitic beds; as, an *infragranitic* origin. (Standard)

Infralias. Same as Rhaetic beds. (Standard)

Infralittoral. In geology, below the region of littorial deposits. (Webster)

Inframundane. Situated below the earth's surface. (Standard)

Infusorial earth; Diatomaceous earth; Tripolite. An earthy substance or soft rock composed of the siliceous skeletons of small aquatic plants called diatoms (U. S. Geol. Surv.). (A former and common, but incorrect usage. Properly Diatomaceous earth.) Useful as an absorbent of nitroglycerin. Called also Infusorial silica and Fossil flour, and in special forms Rottenstone and Electro-silicon; Kieselguhr.

Ingate. 1. An opening in a mold through which melted metal enters in casting; a gate. 2. The point of entrance from a shaft to a level in a coal mine. (Standard)

Ingaun e'e (Ingoing eye) (Scot.). A drift or mine starting from the surface of the ground; also the end of the mine at the surface. (Barrowman)

Ingeniero (Sp.). Engineer; *E. civil*, a civil engineer; *E. de minas*, a mining engineer. (Halse)

Ingenio (Peru). 1. Engine. 2. A crude ore-mill, used in *patio* amalgamation. 3. (Mex.) An amalgamating mill, driven by a water wheel *below* the grindstones. *See also* Injenio. (Dwight)

In-going. That which is going inby. (Gresley)

Ingot. A cast bar or block of metal. (Raymond)

Ingot iron. A malleable, nonhardening product of the Bessemer or open-hearth process. Called also Mild steel and Cast steel. (Standard)

Ingot mold. A mold in which to cast ingots. (Standard)

Ingrain (Eng.). A portion of coal given above the quantity purchased for good measure: usually a quarter-chaldron added to five chaldrons. (Standard)

Inhaler. Something from or through which one inhales; specifically, an appliance or apparatus of different forms and uses, as, for taking the chill from the air before it reaches the lungs; for filtering out iron-dust or other injurious substances from the air breathed through it; for administering medicines by inhalation or, for supplying fresh air to a diver or miner. (Standard)

Injection theory. The theory that a vein was filled first with molten mineral. (Raymond)

Injector. A device for injecting feed water into a steam boiler by the direct action of live steam. (Webster)

Injenio (Peru). A horizontal water wheel and Chilean mill combined. *See also* Ingenio. (Pfordte)

Injunction. A judicial order or process, operating upon the person, requiring the party to whom it is directed to do or (usually) refrain from doing some designated thing. (Standard)

Ink stone. Same as Copperas or Green vitriol. (Standard)

Inlet. A bay or recess, as in the shore of a sea, lake or river; a narrow strip of water running into the land or between islands. (Webster)

Inlier. An older deposit exposed by the removal of a portion of an overlying stratum.

Inmost. Being at a point, place, or position farthest from the exterior; deepest within; innermost; as, the *inmost* depths of a mine. (Standard)

In-over; In-o'er. Same as Inby.

In place. Said of rock, occupying, relative to surrounding masses, the position that it had when formed (Raymond). *See* In situ. If an ore body is continuous to the extent that it may maintain that character, then it is 'in place.' (Iron Silver Mining Co. *v.* Cheeseman, 8 Fed. Rept., p. 301)

Inquartation. *See* Quartation.

In re (L.). In the matter of; used especially in legal phaseology. (Century)

Insalmoro (Sp.). Salting the *torta*. (Egleston)

Insequent. In geology, developed on the present surface but not consequent on nor controlled by the structure; said of streams, drainage, and dissection of a certain type. (La Forge) A type of drainage in which young streams flowing on a nearly level plain wander irregularly. (Lahee, p. 338)

Inset (Eng.). The entrance to a mine at the bottom or part way down a shaft where the cages are loaded. A landing. (Gresley)

Inside. A term often used to designate the interior of a mine.

Inside foreman, or Superintendent. An underground foreman or superintendent.

Inside parting. A side track or parting some distance from the beginning of a long entry, at which cars are left by a gathering driver. Also called a Swing parting. (Steel)

Inside slope. A slope on which coal is raised from a lower to a higher entry, but not to the surface. (Steel)

In situ. In its natural position or place; said specifically, in geology, of a rock, soil, or fossil, when in the situation in which it was originally formed or deposited (Webster). *See* In place.

Inspan (So. Afr.). To harness or yoke up animals. (Standard)

Inspector. One employed to make examinations of and to report upon mines and surface plants relative

to compliance with mining laws, rules and regulations, safety methods, etc. State inspectors have authority to enforce State laws regulating the working of the mines.

Inspirator. A kind of injector for forcing water by steam. *See* Injector. (Webster)

Inspissated. Thickened as by evaporation and oxidation, as for example the pitch or gum resulting from petroleum after long exposure. (Roy. Com.)

Installment bond. An interest-bearing bond payable, principal and interest, in equal annual installments. (E. B. Skinner, p. 140)

Instratified. Same as Interstratified. (Standard)

Instroke. The right to take coal from a royalty to the surface by a shaft in an adjoining royalty. A rent is usually charged for this privilege. (C. and M. M. P.)

Instrumentos (Sp.). Instruments; tools. (Min. Jour.)

Insufflator. A kind of injector for forcing air into a furnace. (Webster)

Insulate. To separate from conducting bodies by means of nonconductors, as to prevent transfer of heat or electricity. (Webster)

Insulator. 1. A nonconducting substance or body used in insulating electric wires, etc. (Webster)
2. A substance that is a nonconductor of electricity, heat, or sound. (Standard)

Intake. 1. The passage by which the ventilating current enters a mine. *See* Downcast, which is more appropriate for a shaft; Intake for an adit, or entry. (Raymond)
2. The air current moving toward the interior of the mine. 3. In hydraulics, the point at which water is received into a pipe or channel. (Century) The suction pipe for a pump.
4. (Scot.) One who works underground at odd work. (Gresley)

Intake area. That part of the surface of the lithosphere where water passes into the lithosphere on its way to the zone of saturation. (Meinzer)

Intendencia (Mex.). An official district. (Dwight)

Intendente (Sp.). 1. Superintendent, overseer, chief. (Hanks)
2. A public officer in charge of the public treasury of a province. (Halse)

Interbedded. Occurring between beds, or lying in a bed parallel to other beds of a different material; interstratified. (Webster)

Intercalary. Inserted or coming between others; introduced or existing interstitially: as intercalary beds in geology. (Century)

Intercalate. To insert among others as a bed or stratum of lava between layers of other material; to interstratify. (Webster)

Intercepts. In crystallography distances cut off on axes of reference by planes. (A. F. Rogers)

Intercolline. Placed between hills: applied specifically in geology to depressions between the cols and crateriform hillocks of volcanic regions (Standard). *See also* Col.

Interés (Sp.) Interest. (Halse). *I. del oro* (Mex.), the greatest sale value of gold. (Lucas)

Interestuarine. Situated between two estuaries. (Standard)

Interfacial angle. In crystallography, the internal diahedral angle between any two faces of a crystal or a crystal form. (La Forge)

Interfelted. So intimately forced together by pressure and heat as to produce interlocking of structure along contiguous surfaces; said of different kinds of strata. (Standard)

Interference color. Colors produced by the destruction or weakening of certain wave lengths of a composite beam of light by interference. An important element in the determination of minerals in thin section under the polarizing microscope. (Webster)

Interference figure. A system of colored rings and curves combined with black bars and curves seen when a thin section of a mineral is examined in a certain way through the microscope or other suitable optical instrument. The interference figure is due to birefringence (*which see*), and is one of the most useful optical aids in identifying minerals. (Ransome)

Interfluent. Applied to those igneous magmas which discharge from a volcano by way of subsurface cavities within the cone. *See also* Superfluent and Effluent. (Dana)

Interfluve. The territory intervening between two neighboring rivers. (Standard)

Interglacial. Of, pertaining to, or designating, a comparatively warm epoch occurring between two glacial epochs. (Webster)

Intergrowth. The interlocking of crystals due to their crystallizing at the same time and in contact with one another. (George)

Interjointal. Situated or occurring between joint planes of rocks. (Standard)

Interleaved. Lying in seams between layers of rock. (Standard)

Interlobate. Situated between lobes; specifically in geology lying between adjacent glacial lobes, as deposits. (Century)

Interlocking tile. Roofing tile having ridges and grooves which interlock when the tile are laid on the roof. (Ries)

Intermine. To intersect or penetrate with mines. (Webster)

Intermontane. Lying between mountains. (Century)

Internal-combustion. Designating or pertaining to any engine in which the heat or pressure energy necessary to produce motion is developed in the engine cylinder, as by the explosion of gas. (Webster)

International metric carat. *See* Carat, 3.

Interpenetration twins. Two or more crystals in twinned position which penetrate each other. (Butler)

Interrupter. In electricity, a device for rapidly and frequently breaking and making an electric circuit, as in an induction coil. (Standard)

Intersecting vein. A vein or lode which cuts across one of earlier formation. (U. S. Min. Stat., pp. 586, 592)

Intersertal. In petrology, having the later-formed minerals, and the rock glass, if there is any, filling the interstices in a network of crystals of the earliest-formed mineral: said of the texture of some diabases and coarse-grained basalts. (La Forge)

Interstice. An opening in anything or between things; especially, a narrow space between the parts of a body or things close together; a crack; crevice; chink; cranny. (Standard)

Interstitial. Of, pertaining to, existing in, or forming an interstice or interstices. (Standard)

Interstitial deposits. Deposits that fill the pores of rocks, and frequently used in place of impregnation deposits. (Eng. and Min. Jour., vol. 75, p. 257)

Interstratification. The state of lying between other strata: in geology, the condition of a bed, stratum, or member of an aqueous deposit with reference to the overlying and underlying beds. (Century)

Interstratified. Interbedded; strata laid between or alternating with others. (Roy. Com.)

Interstrial. Between striæ. (Standard)

Intertrappean. Lying between beds of trap. (Standard)

Interveined. Intersected with or as with veins. (Standard)

Interventor. 1. (Sp.). A mine inspector, representing the interests of the proprietors by whom he is appointed. (Min. Jour.) *See* Fee engineer. 2. (Mex.) A trustee or receiver for a mine in dispute. (Dwight)

Into the house (Newc.). The upstroke of a pumping engine. (Min. Jour.)

Into the solid; On the solid. Said of a shot which goes into the coal beyond the point to which the coal can be broken by the blast. (Steel)

Intraformational. Formed by, existing in, or characterizing the interior of a geological formation. (Standard)

Intramontane. Situated or acting within a mountain. (Webster)

Intratellural. In geology, same as Intratelluric. (Standard)

Intratelluric. Taking place deep within the earth. For example, the large phenocrysts of a porphyry are usually of intratelluric crystallization. (Kemp)

Intrusion. In geology, a mass of igneous rock which, while molten, was forced into or between other rocks. (La Forge)

Intrusion displacement. Faulting coincident with the intrusion of an igneous rock. (Ransome)

Intrusive. In petrology, having, while molten, penetrated into or between other rocks, but solidifying before reaching the surface: said of certain igneous rocks; nearly the same as Plutonic and contrasted with Effusive or Extrusive. (La Forge)

Intumesce. To enlarge or expand with heat; to swell or bubble up, as before the blowpipe. (Webster)

Invasión (Mex.). A mining trespass. (Dwight)

Inversion. The folding back of strata upon themselves, as by the overturning of a fold, in such a manner that the order of succession appears to be reversed. (Webster)

Inverted siphon. A pipe or tube in the shape of a siphon, but inverted, as for carrying water across the depression of a ravine to a lower level. (Standard)

Investment. The act of investing or laying out money productively, or converting capital, especially in a permanent manner; also, the money or capital so invested, or the property invested in. (Standard)

Inwalls. The interior walls or lining of a shaft furnace. (Raymond)

Inwan (Scot.). Inward. (Barrowman)

Iodargyrite. *See* Iodyrite.

Iodine. A nonmetallic element of the halogen group, isolated as a shining blackish-gray crystalline solid of peculiar chlorine-like odor. Symbol, I; atomic weight, 126.92; specific gravity, 4.94. (Webster)

Iodite. Same as Iodyrite. (Standard)

Iodyrite. Silver iodide, AgI. Contains 46 per cent silver. Occurs as a mineral. (U. S. Geol. Surv.)

Iola furnace. A natural-gas-fired furnace used at Iola, Kans., for the distillation of zinc. It is a direct adaptation of the Hegeler furnace. (Ingalls, p. 475)

Iolite. *See* Cordierite.

Ion. One of the substances which appears at the respective poles when a body is subject to electrolysis, that one appearing at the anode being called the *anion*, the other the *cathion*. (Webster)

Ionite. A fossil hydrocarbon found in a more or less impure condition in the lignite of Ione Valley, Amador County, Cal. It has a brownish-yellow color and, while only slightly soluble in alcohol, is completely dissolved by chloroform; it yields a brown, tarry oil on destructive distillation. (Bacon)

Ir á pena (Colom.). To find the pay streak; to touch bottom. (Halse)

Ire (Prov. Eng.). Iron. (Standard)

Irestone. Hard clay slate; hornstone; hornblende. (Raymond)

Iridescence. The exhibition of prismatic colors in the interior or on the surface of a mineral; a play of rainbow colors (Dana). Labradorite and some other feldspars show it. The tarnish on the surface of coal, copper pyrites, etc., is sometimes iridescent.

Iridium. A rare metallic element of the same group as platinum which it much resembles, being silver-white, but harder, brittle, and insoluble in its normal state even in aqua-regia. It is one of the heaviest substances known. Symbol, Ir; atomic weight, 193.10; specific gravity, 22.4. (Webster)

Iridosmine. A natural alloy of iridium and osmium. Analyses show 43 to 77 per cent of iridium, 17 to 49 per cent osmium, and a little rhodium, ruthenium, platinum, iron, and copper. (U. S. Geol. Surv.)

Iris. A transparent rock crystal, especially when it exhibits the colors of the rainbow. (Chester)

Irish buggy. A wheelbarrow.

Irish coal (Local, U. S.). Slate or rock; especially when loaded out of the mine in cars.

Irish diamond. A rock crystal (Webster). *See* Bristol diamond.

Irish dividend. An assessment on mining stock. *Compare* Buck-up.

Irish touchstone. Basalt, the stone which composes the Giant's Causeway. (Webster)

Iron. A silver-white metallic element, malleable and ductile, strongly attracted by magnets, readily oxidized (rusted) in moist air, and attacked by many corrosive agents. Symbol, Fe; atomic weight, 55.84; specific gravity, 7.86. (Webster)

Iron alum. A double sulphate of iron and potassium that occurs native and is then called Halotrichite. Called also Alum-feather. (Standard)

Iron black. Finely divided antimony. (Standard)

Iron brucite. A partly decomposed brucite containing iron. Called also Eisenbrucite. (Standard)

Iron by hydrogen. *See* Reduced iron.

Iron chamber. The reverberatory or charge chamber of a puddling furnace where the metal is heated. (Century)

Iron clad. A kind of furnace for roasting mercury ore. (Webster)

Iron clay. Same as Clay ironstone. (Standard)

Iron earth (Eng.). A black pulverulent compound of peroxide of iron and protoxide of manganese, occurring in veins of ironstone in the crystalline schists. (Page)

Iron flint. An opaque, flintlike ferruginous variety of quartz. (Webster)

Iron froth. A fine spongy variety of hematite. (Power)

Iron furnace. A furnace in which iron is smelted or worked in any way. (Standard)

Iron glance. A variety of hematite; specular-iron. (Power)

Iron gymnite. A red variety of derveylite containing iron. Called also Eisengymnite. (Standard)

Iron hat. *See* Gossan.

Iron jack. In the Missouri zinc region, solid flint rock with disseminated specks of black jack (zinc blende). (Webster)

Iron man. 1. (Eng.) A collier's term for a coal-cutting machine. (Gresley)
2. An iron worker; a manufacturer of iron. 3. (Eng.) A kind of iron ore. 4. A man who handles the rails in track laying. (Webster)
5. An apparatus on wheels for supporting a glass-blower's punty while he is blowing large cylinders, as for window glass. (Standard)

Iron-master. One who conducts or manages the founding or manufacture of iron on an extensive scale. (Webster)

Iron mica. A micaceous hematite. (Chester)

Iron mold (Eng.). A yellow lump of iron ore found in the chalk deposits. (Webster)

Iron ocher. Oxides of iron. Red ocher is hematite and yellow ocher is the hydrated oxide, limonite.

Iron piler. A laborer who removes iron from cars, sometimes breaks it, and piles and classifies it according to grade. (Willcox)

Iron powder. *See* Reduced iron.

Iron putty. A mixture of ferric oxide and boiled linseed oil, used by mechanics in making pipe joints. (Webster)

Iron pyrite. *See* Pyrite.

Iron-reduction process. *See* Precipitation process.

Iron runner. The spout by which iron flows from the tap hole of a blast furnace. (Willcox)

Iron sand. Sand containing particles of iron ore, usually magnetite.

Iron saw. A circular saw for cutting iron. (Standard)

Iron scale. A film of oxide forming on iron. (Standard) *See also* Forge scale.

Iron shears. 1. A machine for cutting iron plates or bars. 2. A pair of hand shears for cutting sheet iron or iron wire. (Standard)

Iron-shot. Shot with iron; having markings due to iron. Said of certain minerals. (Webster)

Ironsmith. A worker in iron, as a blacksmith. (Standard)

Iron spar. Siderite or chalybite. (Power)

Iron steel. A material formed of iron between steel surfaces, or of steel-coated iron. (Standard)

Ironstone. Any ore of iron from which the metal may be smelted commercially, but usually restricted to stratified ores, especially to clay-ironstone—the ore from which most of the iron of Great Britain is made. (Roy. Com.)

Ironstone blow (Aust.). A ferruginous gossan. (Webster) *See also* Gossan.

Ironstone casing (Aust.). The casing of ferruginous matter, usually auriferous, found abutting on quartz reefs. (Davies)

Ironworker. One engaged in manufacturing iron or ironwork. (Standard)

Ironworks. An establishment for the manufacture of iron or of heavy ironwork. (Standard)

Irrespirable. Not respirable; not fit to be breathed (Standard). Said of mine gases.

Irruption. In geology, the movement of molten rock from a magmatic reservoir to the place where it solidifies: if the molten rock reaches the surface the process becomes *eruption*, but that term commonly includes other phenomena as well. (La Forge)

Irruptive rock. An igneous rock which was forced into or invaded other rocks as molten magma. An intrusive rock. The distinction between *irruptive* and *eruptive* is often disregarded. (Ransome). *Compare* Effusive.

Isbell table. A table with a reciprocating motion in which there is no cross-wash water. The bed of pulp is deep as in a jig, and heavy material goes to the bottom. The concentrates and tailings are then split by means of a cut-out, which can be adjusted vertically to skim at any height desired. The riffles make an angle of about 20° with the line of motion of the table. (Liddell)

Iseria; Iserine; Iserite. Titanic iron sand, or ilmenite, supposed to be isometric in its crystallization. (Standard)

Isinglass. Mica in thin transparent sheets. (Webster)

Isinglass stone. Mica. (Webster)

Isle of Wight diamond. A fine transparent variety of quartz. (Power)

Isobase. In geology, a topographic or imaginary contour line in a map, drawn through a series of points of equal elevation in a topographic surface or line, formerly level, but at present deformed. (Standard)

Isochemic lines. Planes or lines of equal content of phosphorus in any single layer of iron ore. (Winchell)

Isoclinal; Isoclinic. In geology, dipping in the same direction; hence, an isoclinal. (Standard)

Isoclinal fold. In geology a stratigraphic fold whose sides have parallel dips: it may be an anticline or a syncline, and either (1) vertical, (2) overturned, that is, forced over into an oblique position, or (3) recumbent, that is, pushed over into nearly or quite a horizontal position. Called also Carinate folds.

Isocline. In geology, a series of isoclinal strata. An anticline or syncline so closely folded that the rock beds of the two sides or limbs have the same dip. (Webster) Also called an Overturn, or Overturned anticlinal. *See* Monoclinal, 3; *also* Isoclinal fold.

Isodiametric. In crystallography, having the lateral crystal axes equal: said of crystals of the hexagonal and tetragonal systems. (La Forge)

Isodimorphous. In mineralogy, both isomorphous and dimorphous: said of certain groups of minerals. (La Forge)

Isomorphous. In mineralogy, of analogous composition and closely similar crystalline form: said of certain groups of minerals. (La Forge)

Isogeotherm. A line or curved surface beneath the earth's surface through points having the same mean temperature. (Webster) Also called Isogeothermal lines.

Isogonic line. An imaginary line joining places on the earth's surface at which the variation of the magnetic needle from the meridian or true north is the same. (Webster)

Isohalsine. A line connecting points of equal salinity in the waters of the ocean. (Century)

Isohyetal. Marking equality of rainfall. (Century)

Isomagnetic. Designating or pertaining to lines connecting points of equal magnetic force. (Webster)

Isomeric. Composed of the same elements united in the same proportion by weight, but differing in one or more properties owing to difference in structure. (Webster)

Isomeromorphism. Isomorphism between substances having the same atomic proportions. (Century)

Isometric. 1. Characterized by equality of measure. 2. *See* Isometric system.

Isometric system. In crystallography, that system of crystals in which the forms are referred to three equal mutually perpendicular axes. (La Forge)

Isomorphous mixture. A solid solution of two or more isomorphous substances. (A. F. Rogers)

Isoseismic line. An imaginary line connecting all points on the surface of the earth where an earthquake shock is of the same intensity.

Isostasy. General equilibrium in the earth's crust, supposed to be maintained by the yielding or flow of rock material beneath the surface under gravitative stress. (Webster)

Isostatic. Subject to equal pressure from every side; being in hydrostatic equilibrium. (Webster)

Isotherm. A line joining points on the earth's surface having the same temperature at a given time, or the same mean temperature for a given period. (Webster)

Isotope. A group of two or more radio elements occupying the same place in the Periodic table and chemically nonseparable and identical; independent of atomic mass, the nature of the parent element, and the sequence of changes in which they result. *See also* Pseudoisotopy. For discussion *See* Soddy, The Chemistry of the Radio-Elements, Pt. II, p. 5.

Isotropic. Having the same properties in all directions. Said of a medium with respect to elasticity, conduction of heat or electricity, or radiation of heat or light. (Century)

Istrian stone. A marble near Trieste, from which Venice is largely built.

Ita. A Japanese gold-washing board.

Itabirite. 1. A metamorphic rock, first described from Brazil, of schistose structure and composed essentially of quartz grains and scales of specular hematite. Some muscovite is also present. It is a close relative of itacolumite. It was named from Itabira, a place in Brazil. When it crumbles to powder it is called Jacutinga. (Kemp)
2. A specular iron ore. (Dana)

Itacolumite; Flexible sandstone. A variety of metamorphosed sandstone, slabs of which will bend noticeably without breaking. (U. S. Geol. Surv.)

Itaipava (Braz.). A sort of screen used in rapid rivers behind which the rich gold-bearing sands accumulate. (Halse)

Itambamba (Braz.). A plant whose juice is said to help catch fine gold.

Itatli (Mex.). An Aztec name for obsidian. (Halse)

Ivory porcelain. A ware having a surface resembling ivory, produced by depolishing the vitreous glaze.

Ixolyte. An amorphous, hyacinth-red, greasy hydrocarbon mineral which softens at 76° C., and resembles hartite; it is found at Oberhart, near Gloggnitz, Austria. (Bacon)

Ixtajales (Mex.). An earthy oxide of iron, often containing sulphide of silver, or native-silver threads. (Halse)

Iztli (Mex.). A cutting implement made from a flake of obsidian. (Standard)

J.

Jabón. 1. (Sp.) Soap; *J. de montaña*, soapstone or steatite. 2. (Colom.) A slickenside. (Halse)

Jaboncillo (Mex.). Decomposed talcose rock, or hardened clay, generally found in a vein, and sometimes indicating the proximity of rich ore. (Dwight)

Jaca (Braz.). Spots in diamonds. (Halse)

Jacal (Mex.). 1. A hut in which tools and ore are kept. 2. A covering over a shaft to keep out rain; a shaft house. (Halse) Also spelled Xacal.

Jacaranda (Braz.). A wood from which stamp stems are made by natives. (Halse)

Jacinto (Sp.). 1. Hyacinth, a transparent red variety of zircon. 2. Cinnamon stone, a variety of garnet. 3. A dark red quartz. (Halse)

Jack. 1. Zinc blende. *See* Sphalerite (U. S. Geol. Surv.)
2. A jack-screw attached to a pointed pipe and used for holding an electric coal-mining machine in position while at work. Also called a Pipe-jack. 3. A tin bucket with pouring spout in which powder in quantities of 5 to 12½ pounds is carried into the mine. (Steel)
4. (No. of Eng.) A lantern-shaped case made of tin in which safety lamps are carried in strong currents of ventilation. 5. (Scot.) One who works underground at odd work. (Gresley)
6. (Scot.) A narrow dyke usually of igneous rock. (Barrowman)
7. A wooden wedge for separating rocks rent by blasting. (Webster)
8. A rod or post set up in the working room of a mine to which a rope is fastened for the purpose of moving the cutting machine from place to place. (Robinson *v.* Virginia-Pocahontas Coal Co., 88 S. E. Rept., p. 623)
9. (No. of Eng.). A large fissure or crack in the mine roof. (Gresley)

Jackanapes (Eng.). The small guide pulleys of a whim. (Century)

Jackass pick. A pick with a protecting wing to support the helve so that the implement may be used as a lever. (Webster)

Jack engine (Eng.). A donkey engine; a small engine employed in sinking a shallow shaft. (Century)

Jacket. A covering to prevent radiation of heat, as the jacket of a steam boiler; also, a casing around a furnace hearth in which water is allowed to stand or circulate to keep the walls cool. (Raymond)

Jackhammer. A nonreciprocating or hammer type of rock drill worked without a tripod and provided with an automatic rotating device. It uses hollow steel through which the exhaust air passes and blows the cuttings from the drill hole (Bowles). *See* Rock drill.

Jack-head pit. A small shaft sunk within a mine (Raymond). A winze.

Jack-head pump. A subordinate pump in the bottom of a shaft, worked by an attachment to the main pump rod. (Raymond)

Jack-head set (Newc.). The set of pumps in the jack-head staple. (*Min.* Jour.)

Jack-head staple (Eng.). A small mine for the supply of coal for the boilers. (Bainbridge)

Jack hole (Eng.). In coal mining, a bolt hole (Standard). *See also* Cut-through.

Jack-knifing. A collapsing of square-set timbers by wall pressure or through imperfect erection. (Sanders, p. 68)

Jack lamp (Eng.). A Davy lamp, with the addition of a glass cylinder outside the gauze. (Century)

Jack pipe. A hollow iron pipe large enough to slip over the end of the front jack of a cutting machine so as to make it hold more firmly against the coal. (Morris *v.* O'Gara Coal Co., 181 Illinois App., p. 311)

Jack pit (No. of Eng.). A shallow shaft in a mine communicating with an overcast. (Gresley)

Jack roll. A windlass worked by hand. (Gresley)

Jack setter. A miner who assists in the operation of a coal-cutting machine, one of whose duties is to see that the roof of the mine at or near the machine is in a reasonably safe condition. (Haggard *v.* McGrew Coal Co. (Mo.), 200 S. W. Rept., p. 1072)

Jackshaft. 1. An intermediate shaft. *See* Jack pit. (Standard). A winze. 2. A column or bar held in place by screw jacks to support or steady a rock drill.

Jackshay; Jackshea (Aust.). A tin pot holding a quart. (Webster)

Jacky pit. *See* Jack pit.

Jacobsite. A deep black, magnetic mineral, $(Mn,Mg)O.(Fe,Mn)_2O_3$. Isometric; in distorted octahedrons. (Dana)

Jacob's staff. A single straight rod, pointed and iron shod at the bottom and having a socket at the top; used instead of a tripod for supporting a compass. (Webster)

Jacupirangite. In petrology, a granular plutonic igneous rock of indefinite composition, containing essential magnitite and pyroxene with accessory nephelite, ilmenite, apatite, olivine, etc., in various proportions. (La Forge)

Jacutinga; Jacutings (Brazil). The various colored iron ores associated with and often forming the matrix of the gold in the Brazilian mines. So called from their resemblance to the colors of the plumage of the Brazilian bird *pipile jacutinga*. (Davies) *Compare* Itabirite.

Jad (Som.). 1. A long and deep holing, cutting, or jud, made for the purpose of detaching large blocks of stone from their natural beds. (Gresley)
2. (Prov. Eng.) To undercut (coal or rock). (Standard)

Jadder. A stonecutter. (Webster)

Jadding. The operation of forming a jad (Gresley). *See* Holing; Jad, 1.

Jadding pick. The tool employed to cut a jad. (Gresley)

Jade; Jadite; Nephrite. A hard and extremely tough material of varying composition, greenish white to deep green in color, used in making carved ornaments. Part of the so-called jade is jadeite, a variety of pyroxene, essentially a metasilicate of sodium and aluminum. Part is nephrite, a variety of amphibole, and essentially a metasilicate of iron, calcium, and magnesium; and part is a variety of saussurite, which is commonly a complex alteration product of plagioclase feldspar. Williamsite, a variety of serpentine, is sometimes mistaken for jade. (U. S. Geol. Surv.)

Jadeite. *See* Jade.

Jag bolt. A bolt with a nicked or barbed shank which resists retraction, as when leaded into stone (Webster). Also called Barb bolt.

Jaggers (Derb.). Both men and horses employed to carry ore from the mine to the smelter. Also called Jagger lads and Jagger horses. (Hooson)

Jagging. A mode of carrying ore to the reduction-works in bags on horses, mules, etc. (Raymond)

Jagging board. An inclined board on which ore slimes are washed, as in a buddle. (Standard)

Jagua (Colom.). 1. A fine powder; metalliferous sands in alluvial deposits. (Halse)
2. *Jaguas;* slimes; pulp; tailings; pulverized ore. (Lucas)

Jagüero (Colom.). A vessel for depositing gold-bearing concentrate awaiting final separation. (Halse)

Jailer (Som.). A small tub or box in which water is carried in a mine. (Gresley)

Jales; Jalsontles (Mex.). Rich tailings or middlings from concentration or amalgamation. (Dwight)

Jalón (Mex.). A tall survey-stake; range pole (Dwight). *J. de esquina,* a corner stake. (Halse)

Jalpaite. A lead-gray, cupriferous, argentite, $(AgCu)_2S$, that crystallizes in the isometric system. (Standard)

Jalsontles (Sp.). Portions of ore not properly ground, and which have to be reground. Also the slime or dust from the washing vats in the amalgamation works. (Rockwell)

Jam. *See* Jamb, 2.

Jamb. 1. A vein or bed of earth or stone, which prevents the miners from following a vein of ore; a large block. 2. A projecting columnar part or mass as of masonry; a pillar as of ore. (Webster)

James concentrator. A concentration table, the deck of which is divided into two sections, flexibly joined together on a line oblique to the line of motion of the table. One section contains riffles for the coarse material while the other section is smooth, to allow the settling of the fine particles which will not settle on a riffled surface. By means of the joint, the slope of the sections can be varied independently. (Liddell)

Jamesonite; Feather ore. A sulphide of lead and antimony, $Pb_2Sb_2S_5$. (U. S. Geol. Surv.)

Jam nut. An extra nut used to secure a principal nut; a lock nut. (Standard)

Jam out (So. Staff.). To cut or knock away the coal between holes. (Gresley)

Jamuración (Colom.). Extracting water from a pit. (Lucas)

Jamurar (Sp.). To extract water from a pit. (Lucas)

Jam weld. A weld in which the heated ends or edges of the parts are square-butted against each other and welded. (Century)

Jap. *See* Rock drill.

Jar. 1. To drill by impact, as a rock; to use a drill jar upon. (Standard)
2. *See* Jars.

Jarcia (Mex.). Fabric or cordage of *Ixtle* fiber. (Dwight)

Jargon. 1. A name given to the colorless or smoky zircons of Ceylon. (Standard)
2. An inferior diamond having a yellowish color. (Century)

Jarosite. A hydrous sulphate of iron and potassium from Jaroso, Spain, (Century)

Jars. In well drilling, a connection between the sinker bar and the poles or cables, made in the form of two links, that slide on each other from 6 to 36 inches. The jars permit the tools to fall on the down stroke, but on the up stroke jar them, or give them a sharp pull, tending to loosen them from any crevices or cavings that may hold them; a drill jar. (Nat. Tube Co.)

Jaspachate; paspagate. Agate jasper. (Webster)

Jaspe (Mex.). Jasper; *J. negro,* Lydian stone, touch stone. (Halse)

Jasper. Red, brown, green, impure, slightly translucent cryptocrystalline quartz with a dull fracture (U. S. Geol. Surv.). Red chalcedony, abundant enough on Lake Superior and elsewhere to be a rock (Kemp). *Compare* Taconyte.

Jasperated. Mixed with jasper; made to resemble jasper; as, *jasperated* agate; *jasperated* glass. (Standard)

Jasperite. Same as Jasper. (Standard)

Jasperize. To convert into a form of silica like jasper; agatized. (Century)

Jasperoid. Resembling jasper. (Century)

Jasper opal. A yellow variety of opal resembling jasper. (Webster)

Jasper ware. A white terra-cotta or porcelain bisque invented by Josiah Wedgewood for use in his cameo-ware: also used for jewelry setting and statuettes. Also called Cameo-ware; Wedgewood-ware. (Standard)

Jasper wash. A dip invented by Josiah Wedgewood in 1777, and used by him to produce the effect of jasper on pottery. (Standard)

Jaspidean. Consisting of or containing jasper; like jasper. (Standard)

Jaspilite. A term used around Lake Superior for the jasper associated with the iron ores. It is made up of bands of bright-red jasper alternating with bands of black, commonly specular hematite. (U. S. Geol. Surv.)

Jaspoid. Resembling jasper. (Standard)

Jasponyx. An onyx part or all of whose layers consist of jasper. (Webster)

Jaspopal. *See* Jasper opal.

Jaspure. Marble veined, or colored like jasper. (Webster)

Jaula (Sp.). 1. Drum of a horse-whim. *J. de extracción*, hoist, cage; *J. de seguridad*, a safety cage. (Halse)

Jaulingite. A resin found in the Jauling, near St. Viet, Lower Austria; it resembles succinite. (Bacon)

Jaum (Derb.). A clay-filled joint extending diagonally across a vein. (Hooson)

Jaw crusher. A machine in which rock is broken by the forcing together of iron jaws. (Richards, p. 1200)

Jay (Derb.). Roof coal. (Gresley)

Jedding ax. A kind of stone mason's ax with a flat face and a pointed peen. (Webster)

Jeffersite. A kind of vermiculite from West Chester, Pennsylvania. (Century)

Jeffrey swing-hammer crusher. A crusher enclosed in an iron casing in which a revolving shaft carries swinging arms having a free arc movement of 120°. The rotation of the driving shaft causes the arms to swing out and strike the coal, ore, or other material, which, when sufficiently fine, passes through the grated bottom. (Liddell)

Jellettite. A green variety of andradite garnet. (Standard)

Jenkin (No. of Eng.). A variation of junking.

Jerry (Aust.). A carbonaceous shale found in coal seams. (Power)

Jerry faces (Aust.). A local name at Lambton B. colliery for main cleats in coal. (Power)

Jerryman. An employee in a mine whose duty it is to clean up falls or refuse, or to make a miner's working place safe. (Peabody-Alwerd Coal Co. *v.* Yandell, 179 Indiana, p. 227; Hartig *v.* Vandalia Coal Co., 98 N. E. Rept., p. 132)

Jeso. Beds of decomposed gypsum. (Standard)

Jet. 1. A dense black lignite, taking a good polish. Sometimes used for jewelry. (U. S. Geol. Surv.)
2. A black marble. (Webster)

Jet coal. Cannel coal.

Jet glass. Crystal glass of pure black, used in cheap jewelry. (Century)

Jet pump. A pump which moves fluid by bringing it in contact with a rapidly moving stream of a fluid, of the same or different kind, the motion being imparted through friction. Injectors and aspirators are pumps of this type. (Meinzer)

Jet rock. Rock or shale containing jet. (Standard)

Jetstone (N. S. W.). Black tourmaline. (Power)

Jetters (Corn.). The horizontal rods or poles connecting the water wheel and the pumps. (Davies)

Jewel. A precious stone; a stone cut and polished for use as an ornament; a gem; a bearing for a pivot in a watch formed of a crystal or precious stone. (Webster)

Jeweler's shop (Aust.). A very rich patch of gold in either a reef or an alluvial formation. (Power)

Jews' houses. Remains of ancient tin smelting furnaces and miners' houses in Cornwall, England. (Webster)

Jews' pitch. A name given to a semi-solid form of bitumen formerly used for medicinal purposes. (Mitzakis)

Jews' tin. Slabs of tin found near the Jews' houses in Cornwall, England. (Webster)

Jewstone. 1. Marcasite. 2. (Eng.) A hard rock of uneven fracture; applied locally to certain basalts, limestone, etc. (Webster)

Jhoras (India). A gold-washing caste. (Lock)

Jig. 1. A machine or apparatus in which ore is concentrated, or coal is separated from slate, on a screen or sieve in water by a reciprocating motion of the screen, or by the pulsion of water through the screen.
2. To separate heavier from lighter materials, as ore from gangue, coal from slate, by agitation in water. (Webster)
3. (Eng.) A self-acting incline (Steel). A jinny road.
4. In well boring, to drill with a spring pole. (Century)

Jig brow. *See* Jimmy road.

Jig chain (So. Staff.). A chain hooked to the back of a skip and running round a post, to prevent its too rapid descent on an inclined plane (Raymond). *Compare* Snub, 2.

Jigger. 1. A workman who sorts or cleans ore by the process of jigging. (Webster)
2. A machine for dressing small ore in which a sieve is dipped or moved about under water (Skinner). *See also* Jig, 1.
3. (Scot.) An apparatus for attaching hutches to a haulage rope, which holds by twisting or biting the rope. (Barrowman)
4. (Aust.) A boy who attends to the brake of a jig, 3. (Power)
5. A coupling hook used between coal cars in Leicestershire coal mines. (Standard)

Jigger work (Eng.). Dressed, or partly dressed, ore obtained from jigging. (Hunt)

Jigging (Corn.). Separating ores according to specific gravity with a sieve agitated up and down in water. The apparatus is called a jig or jigger (Raymond). *See* Jig, 1 and 2.

Jigging machine. A machine with which to jig ore. *See* Jig, 1. (Webster)

Jig indicator. An apparatus resembling a steam engine indicator, for drawing curved lines illustrating the action of jigs in ore dressing. (Webster)

Jig pin (Eng.). A pin to hold the turn beams and prevent them from turning. (Webster)

Jig runner. 1. (York.) The man who works a jig, (a self-acting incline).
2. One who operates a jig for concentrating ore.

Jim-around (West Virginia). A man who does miscellaneous work at mines.

Jim crow. 1. A machine for bending or straightening rails. (Webster)
2. A crowbar with one end clawed like a hammer. (Standard)

Jinny. A stationary engine for hauling on a jinny road, when not operated by gravity. A jinny road. (Webster)

Jinny road. A gravity plane underground. (Raymond)

Jinny tenter. *See* Jig runner, 1; Jinny.

Jito (Mex.). Gate in casting. (Dwight)

Jitty (Leic.). A short heading along which empties, horses, or workmen travel. (Gresley)

Joachimstal process. The extraction of silver from sulphide ores by converting into chloride, leaching with sodium hyposulphite, and precipitating the silver as sulphide with sodium sulphide. (Raymond)

Jock (Scot.). An iron rod, usually pronged, attached to the rear end of a train of hutches or cars being drawn up an incline, to stop their descent in the event of the rope breaking. (Barrowman)

Jockey. 1. (Aust.). A Y-shaped grip placed in sockets at the end of a skip. It is on this that the endless rope rests when used above the skip.
2. (Mid.). A self-acting apparatus on the front of a car, for releasing it from the hauling rope at a certain point. (Gresley)

Joey (Mid.). A man specially appointed to set timber in a stall during the shift. (Gresley)

Joggle. 1. A notch cut in a round timber to prevent rolling when placed on another round piece. (Sanders, p. 115)
2. A joint of trusses or sets of timber for receiving pressure at right angles or nearly so. (C. and M. M. P.)

Joggling table. An inclined board, which moves with a sudden and quick motion, used in washing ore. (Whitney)

John 'Odges. *See* Gun.

Johnston vanner. A vanner in which the chief difference between it and a Frue vanner is that the belt is given an undulating motion to prevent sands from piling up against the edges of the belt. (Liddell)

Johnstrupite. A silicate of the cerium metals, calcium and sodium chiefly, with titanium and fluorine. In prismatic crystals. (Dana)

Joint. 1. In geology, a plane, or gently curved crack or fissure, which is one of an approximately parallel set of fissures ranging from a few inches to many feet apart. Joints occur in rocks of nearly all kinds and generally in two or more sets which divide the rocks into polyhedral blocks. (La Forge)
2. A line of cleavage in a coal seam. (Barrowman)

Joint veins. Small veins confined to one bed of rocks that give no signs of displacement, or at least so slight that they can not be noticed. (Power)

Jointy. Full of joints; specifically, in mining, full of minute cracks or crevices, as rock. (Standard)

Jökull. 1. A glacier. 2. An Icelandic mountain, a large portion of which is above the snow line. Also spelled Jolsul; Yokul. (Standard)

Jolly balance. A very delicate spring balance used especially for the determination of densities by the method of weighing in water and air. (Webster)

Jordanite. A sulpharsenite of lead, $4PbS.As_2S_3$. Monoclinic; often pseudohexagonal by twinning. A lead gray mineral. (Dana)

Joren. A scoop-shaped bamboo basket used in Japan for carrying auriferous gravel. (Lock)

Jornada (or Jornal) (Sp.). 1. Day's work (Dwight). A shift.
2. Day's wages. 3. Daily mineral production by each *peón*. (Halse)

Jornaleros (Sp.). Day laborers. (Min. Jour.)

Jorongo (Sp.). 1. A small basket. 2. A blanket. (Halse)

Joseite. A bismuth-telluride mineral found in Brazil. (Dana)

Josephinite. A native alloy of iron and nickel of the composition Fe_2Ni_3. (Dana)

Jougs; Juggs (Scot.). An iron collar fastened by a short chain to a wall and said to have been put round the neck of disobedient miners in old times as a punishment. (Barrowman)

Joule. 1. A unit of work or energy which is equal to 10^7 ergs, and is practically equivalent to the energy expended in one second by an electric current of 1 ampere in a resistance of 1 ohm. Approximately equal to 0.738 foot-pound. (Webster)
2. The gram-degree centigrade thermal unit; the small calory. (Standard)

Joule's law. 1. The law that the rate at which heat is produced in any part of an electric circuit is measured by the product of the square of the current into the resistance of that part of the circuit. 2. The law that there is no change of temperature when a gas expands without doing external work and without receiving or rejecting heat. (Webster)

Jouph holes (Derb.). Hollows in a vein. (Power)

Journal (Scot.). A record of strata passed through in a bore hole (Barrowman). A log book.

Journey. 1. (So. Wales) A train or set of trams all coupled together running upon an engine plane. (Gresley)
2. The round of work done in converting a quantity of material into glass. (Webster)

Jove. The metal tin. An obsolete term used by alchemists. (Webster)

Jovite. A high explosive consisting of certain nitro compounds and sodium nitrate. Used in armor-piercing shells. (Webster)

Jowl (Newc.). A noise made as a signal, by hammering at the faces of two levels expected to meet. (Raymond)

Juagada (Colom.). Stony, barren deposit. (Lucas)

Juanblanco (Colom.). 1. Platinum found in gold placers. 2. Mica. (Halse)

Jud, Judd. 1. (No. of Eng.). A block of coal about 4 yards square holed and cut ready for breaking down. 2. (Som.) *See* Jad, 1. (Gresley)
3. In whole working, a portion of the coal laid out and ready for extraction; in pillar-working (*i. e.*, the drawing or extraction of pillars), the yet unremoved portion of a pillar. (Raymond)
4. The term jud is also applied to a working place, usually 6 to 8 yards wide, driven in a pillar of coal. When a jud has been driven the distance required, the timber and rails are removed, and this is termed 'drawing a jud.' (C. and M. M. P.)

Judge (Derb. and Newc.). 1. A measuring stick to measure coal work underground. (Raymond)
2. (Eng.) Formerly a boy who proved the holing. (Gresley)

Judge rapper. The upper end of the vertical arm of a judge. *See* Judge, 1. (Gresley)

Juego (Mex.). A set of anything, as a set of repair parts for a machine. (Dwight)

Jugglers. Timbers set obliquely against pillars of coal, to carry a plank partition, making a triangular air passage or manway. (Raymond)

Julgars. An Indian caste whose employment is gold washing. (Lock)

Jumble (Derb.). The place where veins intersect. (Mander)

Jumos (Colom.). Very fine particles of gold found in the *batea* after panning. (Halse)

Jump. 1. (Pac.) *See* Jumping a claim.
2. A dislocation of a vein. (Raymond)
3. (Eng.) To drill a hole for blasting with a jumper. (G. C. Greenwell)

Jumper (Corn. and Newc.). 1. A drill or boring tool, consisting of a bar, which is 'jumped' up and down in the bore hole (Raymond). *See also* Churn drill.
2. One who jumps a claim. *See* 'Jumping a claim.'

Jumping a claim. 1. Taking possession of a mining claim which has been abandoned. 2. Taking possession of a mfning claim liable to forfeiture owing to the requirements of the law being unfulfilled. 3. Taking possession a mine or claim by stealth, fraud or force. 4. The location of a mining claim on supposed excess ground within staked boundaries of an existing claim on the theory that the law governing the manner of making the original location had not been complied with.

Jumping switch (Scot.). A self-acting switch, so arranged that the hutches jump through a small vertical distance. (Barrowman)

Jump joint. A butt joint, made by jump welding (Standard). *See* Jump weld.

Jump-up; Jump-down. 1. An up-throw or a down-throw fault. 2. To raise boring rods and allow them to fall by their own weight. (Gresley)
3. (Jump-up) A short rise dug in the roof of a drive. *See* Monkey shaft. (Duryee)

Jump weld. A weld of metal effected by hammering together the butt ends of two pieces heated to the welding point. (Standard)

Junkerite. Same as Siderite. (Century)

Junket (Eng.). *See* Kibble.

Junking (No. of Eng.) An opening cut into, or a narrow slice taken off, a pillar in the room-and-pillar system of working coal (Gresley). A *fast junking* is a narrow place driven lengthwise in a pillar of coal, but unholed into the room on either side of the pillar. A *loose junking* is a similar place driven along the side of the pillar and open to the room along that side. (G. C. Greenwell)

Junta (Sp.). 1. A nearly vertical joint in stratified rocks; *J. de terrenos*, a fault or break in coal beds.
2. A board, congress, assembly, or council. *Juntas* (Mex.), conciliatory meetings called by the mining agents to settle disputes about mining property. (Halse)

Jupiter process. A patented process for making cast-steel by melting wrought-steel scrap with about 2 per cent ferrosilicon up to about 0.5 per cent ferromanganese and about 3 per cent aluminum and casting in molds of a special composition. (Webster)

Jupiter steel. A steel produced by the Jupiter process. It is about as strong and as ductile as forged steel. (Webster)

Juquero (Peru). A thief who takes ore from the vein. (Dwight)

Jurásico (Mex.). Jurassic. (Dwight)

Jurassic. In geology, the middle one of the three periods comprised in the Mesozoic era. Also the system of strata deposited during that period. (La Forge)

Justiceman (Scot.). One who checks, on behalf of the miners, the weight of mineral sent by them out of the mine (Barrowman). *See* Check weighman.

Juvenile water. Water from the interior of the earth which is new or has never been a part of the general system of groundwater circulation. *See* Magmatic water.

Juzgado (Sp.). A court of justice. (Halse)

K.

Kabaite. A hydrocarbon related to ozocerite or scheererite, found in meteorites. (Bacon)

Kackle-meckle (Corn.). The poorest kind of lead ore (Raymond). A variation of Keckle-meckle.

Kain coal (Scot.). Produce of the mine by way of whole or part payment of rent. (Barrowman)

Kainite. A natural salt containing when pure 35.1 per cent potassium sulphate, 24.2 per cent magnesium sulphate, 18.9 per cent magnesium chloride, and 21.8 per cent water of hydration. (Dana)

Kal (Eng.). A coarse kind of iron. (Anderson)

Kalamein. 1. An anticorrosive alloy of lead, tin, antimony, bismuth, and nickel for coating iron. 2. To coat in a manner similar to galvanizing, but using kalamein. (Webster)

Kaliborite. *See* Heintzite.

Kalinite; Potash alum. Hydrous aluminum-potassium sulphate, $K_2SO_4 \cdot Al_2(SO_4)_3 + 24H_2O$. (U. S. Geol. Surv.)

Kalium. Potassium: the Latin form of the word *kali*, signifying *potash* (Standard). Chemical symbol, K.

Kallait. Turquoise.

Kallen. *See* Callen.

Kamarezite. A grass-green, hydrated, basic copper sulphate, $Cu_3(OH)_4 \cdot SO_4 \cdot 6H_2O$. (Standard)

Kame. 1. (Scot.). A rounded hill or oblong ridge terminating abruptly in a high mound. Composed of gravel and sand, and having its major axis transverse to the drift movement. (Thompson)
2. One of the hills or ridges formed of detritus by glaciers in the line of their track, or even any small conical hill: loosely used interchangeably with *esker* and *eskar*. (Standard)

Kame plain. A broad, low, massive kame, composed only of coarse sediment. (Standard)

Kämmerling furnace. A modification of the Belgian zinc smelting furnace wherein there are two combustion chambers separated by a central longitudinal wall. In principle the furnace is similar to the Hauzeur a compound. (Standard)

Kampong (Malay). An inclosed space; furnace. (Ingalls, p. 444)

Kanchana (Malay). Gold. (C. G. W. Lock)

Kand; Cand (Corn). Fluorspar. (Power)

Kank (Mid.). A twist in a rope (Gresley). A variation of kink.

Kankar (Hind.) A concretionary limestone found in India and used for making roads. It yields an excellent lime for mortar. (Standard)

Kann. *See* Cand.

Kaolin; China clay; Porcelain clay. A clay, mainly hydrous aluminum silicate, from which porcelain may be made (U. S. Geol. Surv.). *See also* Kaolinite.

Kaolinic. Pertaining to, allied to, or resembling kaolin. (Webster)

Kaolinite. A white soft earthy mineral consisting of a hydrous silicate of aluminum and one of the chief constituents of clay. A common product of rock decay and of oxidation in veins (Ransome).

Kaolinization. The decomposition of certain rock-forming minerals to kaolin or clay. (Farrell)

Kaple. *See* Capel.

Karang (Malay). A layer of tin-bearing gravel. Also spelled Karong.

Karat. *See* Carat.

Karn; Cairn (Corn.). A pile or heap of rocks, as for a monument; sometimes the solid rock.

Karstenite. Anhydrite.

Kast furnace. A small circular shaft furnace with three or four tuyères, for lead smelting. (Raymond)

Katabothron (Mod. Greek). An underground passage cut by water. (Standard)

Katalysis; Katalytic. *See* Catalysis.

Katamorphic zone. The zone of katamorphism corresponds to the zone of rock fracture and is a zone of breaking down. It is especially characterized by solution, decrease of volume and softening of the materials; the processes are destructive, resulting in degeneration. The zone is divided into the belt of weathering and the belt of cementation. *See also* Anamorphic zone. (Watson)

Katamorphism. *See* Metamorphism. Any change in the texture of rocks produced by fracturing and granulation, with recrystallization, whereby rocks become finer-grained and foliated, as the production of gneisses and schists from granite. (Century)

Kati. A Chinese weight equal to 1⅓ pounds. (Skinner)

Kation; Kathion. *See* Cathion.

Katouti. A gold-washing trough of the northwest provinces, India. (Lock)

Kauri resin, or Gum; Copal. A resinous product of the Kauri, found in yellow or brown lumps in the ground where the trees have grown. It is used for making varnish and as a substitute for amber (Webster). Found in New Zealand.

Kavels (Eng.). Lots cast by miners for the working places. (Bainbridge)

Kawishiwin (Lake Superior region). The iron-bearing belt of the Keewatin. The greenstone, or dioritic, (upper) part of the Keewatin. (Winchell)

Kawk (Corn.). Fluorspar. (Power)

Kayak; Kayack; Kiak (Alaska). An Eskimo canoe, usually of skin and completely decked, the covering being laced about the person who sits in an opening near the center; it is about 16 feet long and seldom carries more than one person.

Kazen (Corn.). A sieve. (Davies)

Kazer. *See* Kazen.

Kebble (Eng.). An opaque calcareous spar. (Bainbridge)

Keckle-meckle (Eng.). Lead minerals of the poorest quality. *See* Kackle-meckle.

Kedabekite. A name given by E. von Federow to a dike rock from the Kedabek mines, province of Elizabethpol, Transcaucasia. The rock is finely granular, dark gray in color and consists of basic, plagioclase, lime-iron garnet and a pleochroic pyroxene called violaite. (Kemp)

Keeker (No. of Eng.). An inspector of underground mining. (Century)

Keel (Eng.). 1. A flat-bottomed ship or barge used on the Tyne to carry coal from Newcastle. 2. A barge load of coal containing 8 Newcastle chaldrons or 21⅓ tons avoirdupois. 3. A red iron ocher used for marking lumber (Webster). (Eng.) The same as reddle or red clay. *Also* Keil.

Keel wedge. A long iron wedge for driving over the top of a pick hilt. (C. and M. M. P.)

Keeper. 1. One in charge of opening and closing the tap hole of a blast furnace, and who runs iron at cast. (Wilcox) 2. (Eng.). An engine keeper; a horse keeper, etc. Also a brakeman. (Gresley)

Keeps; Keps. Wings, catches, or rests, to hold the cage when it is brought to rest at the top, bottom or at an intermediate landing (Chance). Also called Shuts, Fans, Chairs, Dogs. *See also* Cage shuts.

Keeve. 1. *See* Cauf. 2. A tub used in collecting grains of heavy ore or metal; a dolly tub (Raymond). A keeve of rich slime is stirred with water, and then struck on the side, which causes the heavy mineral to settle on the bottom (Standard). Also spelled Kieve.

Keeving. The preparation of fine ore, or slime in a keeve. (Standard)

Keewatin. According to the U. S. Geological Survey, the overlying but older of the two series of rocks comprised in the Archean system. Also the corresponding geologic epoch. (La Forge)

Keg. A cylindrical container made of steel or some other substance, which contains 25 pounds of blasting powder or gunpowder (Du Pont). Any small cask or barrel having a capacity of 5 to 10 gallons.

Keil furnace. A gas-fired furnace containing one or more vertical retorts for the distillation of zinc. (Ingalls, p. 395)

Keilhauite. A titano-silicate of calcium, aluminum, ferric iron, and the yttrium metals. (Dana)

Keith process. An electrolytic process for refining lead. The electrolyte is composed of a solution of lead acetate or of lead chloride. Impure lead forms the anode plates, which are inclosed in bags of coarse muslin. The cathodes are made of thin metal plates. The deposit obtained is in crystalline form and falls to the bottom of the vessel, which may be made of plate iron or of wood. (Goesel)

Kelf (Derb., Leic.). The vertical height of the face of the undercut at any time during the operation of undercutting. (Gresley)

Kell (Eng.). A variation of Kiln.

Keller automatic roaster. A six-deck horizontal furnace for calcining sulphide ores. (Hofman, p. 191)

Keller furnace. A multiple-deck roasting furnace for sulphide ore. It is a modification of the Spence furnace. (Ingalls, p. 98)

Kelly. 1. In brickmaking, to cover with mold or soil. 2. Mold overlying clay; surface earth. (Standard)

Kelly filter. An intermittent, movable pressure filter. The leaves are vertical and are set parallel with the axis of the tank. Pulp is introduced into the tank (a boiler-like affair) under pressure and the cake formed. The head then is unlocked and the leaves run out of the tank chamber, by means of a small track, and the cake is dropped. The carriage and leaves are then run back into the tank and the cycle begun again. (Liddell)

Kelp. 1. Large seaweeds such as are used in producing the manufactured kelp. (Century)
2. The ashes of seaweeds, formerly the source of soda as used in glass and soap making, now a source chiefly of iodine. (Standard)

Kelve (Corn.). Fluorspar. (Power)

Kelyphite rim. A name applied by Schrauf to rims of pyroxene, hornblende and spinel that sometimes surround the garnets of peridotites. It is of microscopic application. (Kemp)

Kennel. 1. (Mid.) A collier's term for cannel coal. (Gresley)
2. Also a channel; little canal; gutter.

Kenner (No. of Eng.). An expression meaning time to leave off work. (Gresley)

Kentallenite. A granular plutonic igneous rock, between augite syenite and olivine gabbro, composed essentially of augite, olivine, biotite, andesine, and orthoclase. (La Forge)

Kentish rag (Eng.). A provincial term for the hard, gray, arenaceous limestone of the green-sand formation, much used for building in Kent and Sussex. (Roberts)

Kentledge. 1. A nautical term for pig iron used as ballast. 2. In British military usage, unserviceable cast-iron articles such as condemned shot, and shell, etc. (Webster)

Kent roller mill. A revolving steel ring with three rolls pressing against its inner face. The rolls are supported on springs, and the rings support the roll, so that there is some freedom of motion. The material to be crushed is held against the ring by centrifugal force. (Liddell)

Kenyte. A vitrophyric variety of phonolite containing phenocrysts of anorthoclase. (La Forge)

Keps (Scot.). Movable support for the cage at a landing; shuts (Barrowman). *See* Keeps.

Keramics. Same as Ceramics.

Kerargyrite. Same as Cerargyrite.

Keratophyre. A rock intermediate between porphyries and porphyrites, and differing from each in having as the principal feldspar, anorthoclase instead of either orthoclase or the soda-lime feldspar. Keratophyre applies to pre-Teriary rocks, whereas pantellerite is used for the same aggregate of more recent geological date. The name was given in 1874 by Gümbel to certain Bavarian felsitic and porphyritic rocks, that resembled hornfels, hence the name from the Greek for horn (Kemp). Its significance has since beeen restricted to any variety of syenite porphyry, trachyte, or felsite containing phenocrysts of anorthoclase.

Kerf (Eng.). The undercut made to assist the breaking or mining of the coal (Steel). *See also* Kerve.

Kermesite. A monoclinic, cherry-red mineral, Sb_2S_2O, resulting from the alteration of stibnite (Dana). Also called Kermes mineral.

Kermes mineral. A soft, reddish-brown artificial powder consisting of Sb_2S_3, but usually containing also an oxide and alkali. Kermesite is a native form. (Webster)

Kerned (Corn.). Said of certain ore hardened by exopsure to the sun. (Davies)

Kernel roasting. *See* Roasting.

Kern stone (Local, Eng.). A sandstone of a coarse granular composition. (Standard)

Kernon. An old name for Cornwall. (Pryce)

Kerogen. A term applied to the bituminous material in Scottish oil-shale. (Bacon)

Kerosene. A mixture of hydrocarbons whose average boiling point is about 450° F., freed on the one hand from gasoline or naphtha and on the other hand from the heavy hydrocarbons that belong to gas oil and lubricating oil. (Bacon)

Kerosene shale. Speaking broadly, any bituminous shale from which illuminating oil has been or may be obtained. (Bacon)

Kerrite. A pearly, yellowish-green variety of mica that is closely related to jefferisite. It occurs as fine scales. (Standard)

Kersantite. 1. A very old name of somewhat varying application, but formerly used for rocks that are intermediate between diorites or their corresponding porphyrites and gabbros or diabases. Mica-diabase was used as a synonym (Kemp).
2. A finely granophyric or aphanophyric igneous rock composed of plagioclase and biotite, with or without augite, hornblende, and olivine; a porphyritic diabase or augite diorite with phenocrysts of biotite (La Forge). Kersanton is practically a synonym. Both names are derived from a town in Britany.

Kerve; Kirve (No. of Eng.). To undercut, as in coal mining. (C. and M. M. P.)

Ketches (So. Wales). Same as Backstay.

Kettle. 1. (Scot.) A cylindrical or barrel-shaped iron or wooden vessel used to raise men or materials in shaft sinking. (Barrowman)
2. *See* Kettle hole.

Kettleback. The same as Horseback. (Davis *v.* Nuttallsburg Coal & Coke Co., 34 West Virginia, p. 502)

Kettle bottom. A piece of slate that drops out of a smooth cavity in the roof of a mine. It loosens and falls without giving any warning (Harr). Same as Horseback.

Kettled. In geology, hollowed out like a kettle, as surface bowls by action of a glacier. (Standard)

Kettle dross. Skimmings resulting from the desilveration of lead bullion. It consists principally of lead oxides mixed with metallic lead. (Hofman, pp. 445 and 498, 6th ed.)

Kettle hole. A steep-sided hollow, without surface drainage, especially in a deposit of glacial drift. (Webster)

Kettle moraine. A terminal moraine the surface of which is marked by many kettle holes. (Webster)

Ketton stone. A reddish-brown oölitic limestone from Ketton, England. (Webster)

Keuper. The upper division of the European Triassic formation. (Standard)

Kevel (Derb.). A variation of Kevil.

Kevil. 1. (Derb.). A veinstone, consisting of a mixture of calcium carbonate and other minerals. (Raymond)
2. (No. of Eng.) The amount of coal sent out by the various miners during a certain period. (Gresley)

Keweenawan. According to the U. S. Geological Survey, the uppermost or youngest of the series of rocks comprised in the Algonkian system; it is regarded by some geologists as Lower Cambrian. Also the corresponding geologic epoch. (La Forge) The system includes a body of igneous rocks of prodigious thickness, conglomerates, and sandstones. The copper-bearing rocks of the Lake Superior region are part of the system.

Key. 1. (Eng.) A kind of wrench used for screwing and unscrewing drill rods. Also used to support the rods by resting on top of the casing and allowing the rods to hang by

the enlarged joint coming in contact with the key. (Gresley)
2. A wedge driven between two feathers to break a stone. (Webster)
3. An iron bar of suitable size and taper for filling the keyways of shaft and pulleys so as to keep both together. (Steel)
4. A rectangular depression, in one or both flat sides of a brick, sometimes called Frog or Panel. (Ries)
5. A keystone.

Key blocks. The first blocks which are removed in opening up a new quarry floor. (Bowles)

Key seat. *See* Keyway.

Keystone. 1. The voussoir at the center of the crown of an arch, which, being the last set in place, is regarded as binding the whole together. A bond stone. 2. A filling-in block of cast iron used in some lead smelting furnaces. (Webster)

Keyway; Key seat. A groove or channel in a shaft or pulley for receiving a key. (Webster)

Kibble; Kibbal (Corn. and Wales). An iron bucket for raising ore. (Raymond)

Kibble filler (Eng.). The man fills the kibble with ore, coal, or waste rock. (Bainbridge)

Kibble rope; Kibble chain (Eng.). A rope or chain for hoisting a kibble or bucket. (Standard)

Kick. 1. In brickmaking, a wooden block on the upper face of a stock board to make a key or depression in the bottom of a slop-molded brick. 2. A die for molding brick. (Standard)

Kick back. 1. (Arkansas) To break the coal on both sides of the auger hole which contains the powder, usually along a joint in the coal. (Steel)
2. A track arrangement for reversing the direction of travel of cars moving by gravity. (C. and M. M. P.)

Kicker. 1. Ground left in first cutting a vein, for support of its sides. (Raymond)
2. (Scot.). The reversing gear of some direct-acting steam and hydraulic pumps. (Barrowman)
3. (Eng.). A liberating catch made in the form of a bell-crank lever rocking on a horizontal axis. (Gresley)

Kick-up. 1. (Aust.). An end tippler. (Power)
2. (No. of Eng.). *See* Tipper, 1 and 2.

Kidney ore. A variety of hematite, occurring in compact kidney-shaped masses. (Webster)

Kidneys. 1. (Tenn.). Bowlders of phosphate rock. (Power)
2. A term applied by miners to a mineral zone which narrows down until very thin and then suddenly expands and again suddenly contracts. (Meydenbauer *v.* Stevens, 78 Fed. Rept., p. 791; Rough Rider, In re, 41, Land Decisions, p. 255)

Kidney stone. 1. A nodule of ironstone common in the Oxford clay (Middle Oölite) of England. 2. A tough, compact, fine grained greenish or bluish amphibole; nephrite. (Standard)
3. A pebble or nodule roughly resembling a kidney. (Webster)

Kiefekil; Kefferkil (Persian). 1. A kind of clay. 2. A meerschaum. (Century)

Kies. A general term for the sulphide ores, now adopted into English from the original German. (Kemp)

Kieselguhr. German name for diatomaceous earth, and more or less current in English (Kemp). Used as an absorbent for nitroglycerin in dynamite. It is an inert substance or passive base, whose only value lies in its capacity to absorb about three times its weight in nitroglycerin (Du Pont). *See also* Infusorial earth.

Kieserite. A hydrous magnesium sulphate, $MgSO_4+H_2O$. Usually massive, granular to compact. Color white, grayish, yellowish. (Dana)

Kieve (Corn.). A variation of Keeve, 2.

Kiles (Eng.). Leather strings. (Bainbridge)

Kilkenny coal. Anthracite. (Gresley)

Kill. To mix atmospheric air with fire-damp or other gases so as to make them harmless. (Gresley)

Killas. Cornish miners' term for the slates or schists that form the country rock of the Cornish tin veins. (Kemp)

Killman (Scot.). A kilnman. (Standard)

Killogie (Scot.). The space before the fire in a kiln. (Standard)

Killow (Eng.). A deep blue or blackish earth. (Standard)

Kiln. 1. A furnace for the calcination of coarsely broken ore or stone; also, an oven for drying, charring, etc. (Raymond)
2. A potter's oven for baking biscuit or fictile ware. 3. A furnace for vitrifying, as bricks or porcelain. (Standard)

Kiln-dry. To dry in a kiln. (Webster)

Kiln eye (Scot.). The opening at the bottom of a draw kiln. (Barrowman)

Kilnhole. The mouth or opening of an oven or kiln. (Webster)

Kilnman. A man who tends a kiln. (Standard)

Kiln-run brick. *See* Stock brick.

Kiln white. A scum which originates in the burning of brick. (Ries)

Kilo. A short form of kilogram. (Webster)

Kilocalorie. A great calorie. (Webster)

Kilogram. A unit of weight in the metric system and equal to one thousand grams, or 2.2046 pounds avoirdupois.

Kilometer. A length of one thousand meters, equal to 3,280.8 feet, or 0.621 of a mile: the chief unit for long distances in the metric system. (Standard)

Kilowatt. A unit of power equal to one thousand watts. (Webster)

Kilowatt hour. A unit of work or energy equal to that done by one kilowatt acting for one hour; approximately 1.34 horse-power hour. (Webster)

Kimberley joint. Originally a pipe joint of English manufacture for use in South Africa. It consists of an outer wrought sleeve or ring belled out on the ends to form a suitable lead recess for calking, the pipes butting in the center of the sleeve. (Nat. Tube Co.)

Kimberlite. A name given by H. Carville Lewis to the peridotite that forms the diamantiferous dike at the Kimberley mines, of South Africa. The rock is more porphyritic than typical peridotite (Kemp). Also called Blue earth or Blue ground by miners.

Kimberly method. *See* Combined top-slicing and shrinkage stoping.

Kim-coal. *See* Kimmeridge shale.

Kimmeridge clay. A thick bed of clay, constituting a member of the Oölite (Jurassic) group. So-called, because it is found well developed at Kimmeridge, in the isle of Purbeck, Dorsetshire. (Comstock)

Kimmeridge coal. A bituminous shale or impure coal which occurs in the Kimmeridge clays. (Power)

Kimmeridge shale. Extensive deposits of bluish-gray slaty clay, containing more or less volatile matter, and interstratified with thin beds of highly bituminous shale, occurring in Dorsetshire. This clay, which is a member of the Upper Oölite, attains in places a thickness of as much as 600 feet. Locally, called Kim-coal. (Bacon)

Kimmeridgian. In geology, one of the stages of the Upper Oölite series of the Jurassic system of strata in Great Britain. (La Forge)

Kin. A Japanese weight of 1.31 pounds avoirdupois. (Weed)

Kind (Eng.). Generally signifies tender, soft, or easy to work. Said of certain ores. (Gresley)

Kind-Chaudron process. A process for sinking shafts in which a small pit is sunk in advance and subsequently enlarged to the full size of the shaft, when the tubbing or water-tight lining with its moss box at the bottom is lowered or pressed down into position, and the tubbing backed up with an outside lining of concrete. (Webster)

Kindly. A miner's term for a rock which is considered congenial or likely for carrying ore. (Roy. Com.)

Kindly ground (Eng.). Those rocks in which lodes become productive of mineral of value. (Cox)

Kind's plug. A wooden plug attached to an iron rod, used in connection with sand for recovering tubing from bore holes. (Raymond)

Kingbolt. A bolt supporting a cage in a shaft. (Webster)

Kingle. Barren blaes, or ribs of hard calcareous or quartzose material, destitute of bituminous matter, occurring in the Scottish oil shales. (Bacon)

King-post (Eng.). An apparatus for strengthening a beam. (Bainbridge)

King-pot. The large central pot or crucible in a brass-melting furnace. (Raymond)

King screen. A drum-type screen in which the pulp to be screened is delivered on the outside, the undersize passing through the screen and discharging through the open end. (Liddell)

King's silver. A very pure but soft silver used for plate in the beginning of the 18th century. (Standard)

King's yellow. A bright yellow pigment, As_2S_2. Occurs native as orpiment, and is also made artificially. (Webster)

Kink. 1. (Scot.) A twist in a rope; a doubling and interlocking of several links in a chain. (Barrowman) 2. A deflection in a vein or lode which does not interrupt the continuity thereof. (Voght)

Kinkead mill. A pan mill with a convex conical bottom on which a muller, having two surfaces of different inclinations, grind. The machine acts on the gyratory principle as regards crushing between the surfaces. (Liddell)

Kinoully (Corn.). *See* Kivully.

Kinzigite. A metamorphic rock consisting of biotite, garnet, and oligoclase. It was named, in 1860, by Fischer, from the Kinzig Valley, in the Black Forest. (Kemp)

Kip (No. of Eng.). A level or gently sloping roadway, at the extremity of an engine plane, upon which the full cars stand ready to be sent up the shaft (Century). The tubs, or cars, usually go to the shaft by gravity.

Kir. A Russian name given to petroleum solidified on exposure, and having the appearance of asphalt. (Mitzakis)

Kirchhoff's law. The law that in any branching network of electric wires the algebraic sum of the currents in all of the wires that meet in any point is zero. (Webster)

Kira (Scot.). To bore with a hand jumper or kirner. (Barrowman)

Kirner (Scot.). A hand jumper (drill). (Barrowman)

Kirve (No. of Eng.). To undercut (Gresley). *See* Kerve.

Kirving (Newc.). The cutting made at the bottom of the coal by the miner (Raymond). *See* Holing.

Kish. 1. The blast-furnacemen's name for the graphite segregations seen in pig iron and in the cinder of a furnace making a very gray iron. (Raymond) 2. The dross on the surface of molten lead. (Standard)

Kiss process. About the same as the Patera process (*which see*) except that calcium hyposulphite is used for leaching the ore, and calcium polysulphide for precipitating the silver. (Liddell)

Kist. The wooden box or chest in which the timberman keeps his tools. The chest is always placed at the flat or lamp station. This spot is often referred to by the expression "at the kist." (C. and M. M. P.)

Kisye (Malay). Rattan sieves used in gold washing. (Lock)

Kit. A wooden vessel. (Raymond)

Kitchen. *See* Laboratory, 2.

Kitchens (Eng.). Coal prepared and sold expressly for use in ranges, stoves, etc. (Gresley)

Kitting (Eng.). Thieving in combination. There are different modes of cheating the adventurers (owners) by miners mixing their ores, and sometimes by stealing from heaps not their own and carrying to their own heap. All these thefts are called "kitting." (Hunt)

Kittle (Scot.). Dangerous; risky. (Barrowman)

Kitty (No. of Eng.). A length of about four inches of straw filled with gunpowder by which flame is communicated to the blasting charge. (Gresley)

Kive (Prov. Eng. and Scot.). Same as Keeve. (Standard)

Kiver (Local Eng.). A shallow keeve, *which see.* (Standard)

Kivully (Corn.). Loose ground. (Pryce) Also spelled Kinoully.

Kleeman condenser. A rectangular clay pipe in which distilled zinc is condensed. (Ingalls, p. 550)

Kleinite. A mineral consisting of mercury-ammonium chloride. Formula uncertain. (U. S. Geol. Surv.)

Klinkstone. *See* Phonolite.

Klip (So. Afr.). A rock or stone; cliff, mountain. (Standard)

Kloof (So. Afr.). A mountain pass or cleft; a gorge or narrow valley. (Standard)

Kluft. A fault. (Ure)

Knacker (Prov. Eng.). A collier's horse. (Standard)

Knapper. A stone breaker; specifically one who breaks up flint flakes into sizes used for gun flints. (Century)

Knapping (Scot.). The act of breaking stone. (Standard)

Knapping hammer. A long-handled steel hammer for breaking stones, such as is used for breaking flint flakes. (Standard)

Knapping machine. A stone breaker. (Standard)

Knee joint. A toggle joint. (Standard)

Kneeler (Eng.). A quadrant or triangular lever which converts the horizontal movement of a piston rod into the up and down movement of pump rods. (Webster)

Knee movement. The mechanism that operates a toggle-joint. (Standard)

Knee piece. 1. A bent piece of piping. (C. and M. M. P.)
2. An angular piece of timber used in a roof (mine) to strengthen a joint where two timbers meet.

Knee timber. Timber with natural knees or angles in it. A piece of timber with an angle or knee in it. (Webster)

Knits; Knots. Small particles of ore. (Raymond)

Knob. 1. A round hill or mountain; especially an isolated one (Webster). *See also* Boss, 4.
2. To remove knobs from, as in rough-dressing stone in the quarry. (Standard)
3. A small support for the roof. (Min. Jour.)

Knobbing. The act of rough-dressing stone in the quarry by knocking off the projections and points. (Century)

Knobbing fire. A bloomery for refining cast-iron. (Raymond)

Knock. 1. To examine a mine roof for safety. *See also* Chap. (Gresley)
2. (Local, Eng.). A sand-bank; so-called along the Lincolnshire coast. (Standard)

Knock-back ore (Eng.). Ore mixed with barite or kevil. (Bainbridge)

Knocker. A lever that strikes on a plate of iron at the mouth of the shaft, by means of which miners below can signal to those on the top. (C. and M. M. P.)

Knocker line. The signal line extending down the shaft from the knocker. (C. and M. M. P.)

Knocking. 1. (So. Wales) Signals made underground by knocking on the coal. (Gresley)
2. (Eng.) Ore broken with a hammer, especially the large lumps which are picked out. (Webster)

Knocking-bucker (Eng.). A tool cut out of a strong flat bar of iron, used for breaking or bucking ore. (Duryee)

Knockings. Pieces of stone cut or taken off in blasting or in rough-dressing. (Standard)

Knocking-up (Eng.). The calling up of miners by beating the landing wagon. (Bainbridge)

Knock-off. 1. The point upon an engine plane at which the trip is disconnected from the rope. 2. A joint for disconnecting the bucket from the pump rods. 3. To do away with. (Gresley)
4. To stop (work) for the day or part of a day. *See* Kenner.

Knock-off hook. 1. (Eng.) A hook by which cars may be detached from a rope by the withdrawal of a pin or knocking off a catch. 2. Also a hook by means of which the rope is detached from the cage when it is drawn too high by the winding engine. (G. C. Greenwell)

Knock-off joint. In well drilling, a joint used in the rods of deep-well pumps. The jointed ends of the rods are enlarged to a square section and notched to fit against one another, and are confined by a clasp or bridle embracing them. The joint is tapered lengthwise and the hole in the clasp is tapered to correspond, so that the tendency is always for the clasp to tighten around the joint. (Nat. Tube Co.)

Knockstone (Eng.). A stone or piece of iron on which to break lead-ore. (Bainbridge)

Knoll. A hillock of rounded form; a mound; the top of a hill or mountain. (Webster)

Knots. A term applied by quarrymen to dark gray or black masses, more or less oval or circular in cross section, which are segregations of black mica or hornblende formed in the granite while in a molten state. English quarrymen call them 'heathen.' (Dale)

Knotty. So altered by contact metamorphism as to have new minerals developed, giving a spotted or knotty appearance (Kemp). Sometimes applied to concretions found in sedimentary rock. (Ries)

Known mine. Lands can not be held to be "known mines" unless at the time the rights of the purchaser accrued there was upon the ground an actual and open mine which either had been worked or was capable of being worked. (Colorado Coal, etc., Co. *v.* United States, 123, p. 327; U. S. Min. Stat., p. 746)

Known to exist. A vein or lode is known to exist when it could be discovered by anyone making a reasonable and fair inspection of the premises for the purpose of a location. (Iron Silver Mining Co. *v.* Mike & Starr, etc., Co., 143 United States, p. 403; Min. Stat., pp. 558–562)

Knox and Osborne furnace. A continuously working shaft furnace for roasting quicksilver ores, having the fireplace built in the masonry at one side. The fuel is wood. (Raymond)

Knox hole. A circular drill hole with two opposite vertical grooves which direct the explosive power of the blast. (Perkins)

Knox system. A system of separating masses of rock by blasting with black blasting powder in reamed drill holes, a considerable air space being left between the charge and the stemming. (Bowles)

Knuckle. The place on an incline where there is a sudden change in grade. (Harr) The top of a grade or hill on a track over which mine cars are hauled (Richards *v.* Sloss-Sheffield Steel & Iron Co., 146 Alabama, p. 256; 41 Southern, p. 288.

Koehler furnace. A revolving, cylindrical, muffle furnace used in Upper Silesia. (Ingalls, p. 161)

Koehler lamp. A naphtha-burning flame safety lamp for use in gaseous mines.

Koepe system. A system of hoisting without using drums, the rope being endless and passing over pulleys instead of around a drum. (C. and M. M. P.)

Kokowai (New Zealand). Red ocher; a common native pigment, mixed for use with fish oil or vegetal oil. (Standard)

Komspelter. A proposed trade name for spelter from the Kansas, Oklahoma, and Missouri fields, *Kom* being the initial letters of the three states named. (Min. and Sci. Press, vol. 115, p. 672)

Konite. A magnesian dolomite. (Standard)

Könlite. A reddish brown to yellow, soft, amorphous hydrocarbon mineral that has a specific gravity of 0.88, a melting point of 114° C., and distills at 200° C. (Bacon). Also called Könleinite.

Kopje (So. Afr.). A hillock; knob. (Standard)

Korb (Ger.). *See* Corf, 1.

Koreg (Malay). A stratum of compact yellow clay underlying tin-bearing gravel.

Koswite. A name derived from Mt. Koswimsky, in the Urals, and given by Duparc and Pearce to a melanocratic, granular rock composed of varieties of pyroxene, olivine, hornblende, chromiferous spinels, and magnetite; the last named constituting a matrix or cement for the others. (Kemp)

Koth. A name given by the Spaniards to an earthy, slimy substance ejected from volcanoes in South America. The natives call it Moya. (Humble)

Kraal (So. Afr.). An enclosure or stockade or pen for cattle or sheep. A hut or group of huts for native miners.

Krablite. Ejected blocks from the volcano of Krafla, in Iceland, which were regarded many years ago by Forchhammer, under the name baulite, as a feldspar, of percentage in silica far beyond that of albite. It was soon shown by the microscope to be an aggregate. (Kemp)

Krassyk. A local name for a decomposed ferruginous schist; in the Berseov gold-mining district of the Urals. (Kemp)

Kremnitz white. A pure white lead made by treating litharge and lead acetate with carbon dioxide, and formed into tablets. It is used in fine painting. (Webster)

Krems. Same as Kremnitz white, *which see.*

Krennerite. Orthorhombic telluride of gold and silver. Composition variable, $(Au, Ag)Te_2$. At Cripple Creek analysis gives gold 43.86 per cent, silver 0.46 per cent, tellurium 55.68 per cent. (U. S. Geol. Surv.)

Krohnke process. The treatment of silver ores preparatory to amalgamation, by humid chloridization with copper dichloride. (Raymond)

Krupp ball mill. An ore pulverizer in which the grinding is done by chilled-iron or steel balls of various sizes moving against each other and the die ring, composed of five perforated spiral plates, each of which overlaps the next. The plates form steps which give the balls a drop from one plate to the next, and in addition, give space through which oversize is returned. Outside the die plate is a coarse perforated screen to take the chief wear, while outside that is fine gauze screens. The fines discharge through these into the housing inside which the screens revolve and which has a hopper bottom. (Liddell)

Kruppize. To apply the Krupp hardening process to, as armor plate. (Standard)

Krupp process. 1. *See* Krupp washing process. Called also Bell-Krupp process. (Webster)
2. A cementation-process designed for the hardening of surface steel, as for armor plates, where the object is to strengthen the outer portion of the mass from the surface toward the interior. (Standard)

Krupp washing process. The removal of silicon and phosphorus from molten pig iron by running it into a Pernot furnace, lined with iron oxides. Iron ore may also be added, and the bath is agitated by rotation for five to eight minutes only. *See* Bell's dephosphorizing process. (Raymond)

Kryokonite. Dust of volcanic or cosmic origin found on the ice and snow of the polar regions. (Webster)

Krypton. An inert gaseous element of the argon group, occurring in the air to the extent of about one volume in one million. Symbol, Kr; atomic weight, 82.92. (Webster)

Krystic. In geology, pertaining to or treating of the subject of ice as a surface feature of the earth, in any and all of its forms, including glacier ice; as, *krystic* geology. (Standard)

Kua. Specially shaped hoes used for working gravel in the sluice in Japan. (Lock)

Kugel. The German word for ball or sphere, often prefixed to those igneous rocks that show a spheroidal development, such as corsite, orbicular granite, etc. (Kemp)

Kulaite. A name derived from the Kula basin in Lydia, Asia Minor, proposed by H. S. Washington, for those rare basalts (there abundant) in which hornblende surpasses augite in amount. (Kemp)

Kuli (India). Wages; hire. Also spelled Culy. (Century)

Kullaite. A name derived from the Swedish locality Kullen, and applied by A. Hennig to a dike-rock which is regarded as an intermediate type between the diabases and the granites. In a feldspathic groundmass of ophitic (diabasic?) texture, are red phenocrysts of plagioclase and microcline. The groundmass has rods of oligoclase-andesine with augite, orthoclase and titaniferous magnetite. (Kemp)

Kunkur (Hind.). A nodular or tufaceous concretionary limestone, generally of an ash-gray or dove-gray color; occurs both in layers or beds, often of considerable thickness and extent, and in detached nodular concretions of various size, imbedded in stiff clay. (Oldham)

Kunzite. A lilac-colored or pink spodumene. Used as a gem. (U. S. Geol. Surv.)

Kupfernickle (Ger.). Niccolite. (Standard)

Kupferschiefer (Ger.). A dark-colored shale of the Permian, worked for copper, in Germany. (Standard)

Kuskite. A name derived from the Kuskokwin river, Alaska, and applied by J. E. Spurr to certain porphyritic dikes, which cut Cretaceous shales, and which have phenocrysts of quartz, scapolite, and probably basic plagioclase (the last now represented by alteration products), in a groundmass of quartz, orthoclase, and muscovite. *Compare* Yentnite. (Kemp)

Kutch. In gold beating, a package of vellum leaves between which sheets of gold are placed for the first beating. (Standard)

Kutter's formula. A formula for estimating the flow of water in rivers and canals, and sometimes modified for estimating the flow through long pipes with low velocity and entrance head. (Webster)

Kyack. 1. (West. U. S.) A pack sack to be swung on either side of a pack saddle. (Webster)
2. (Alaska) *See* Kayak.

Kyanite. The same as Cyanite. (A. F. Rogers)

Kyanize. To treat wood by the process of kyanizing. (Century)

Kyanizing. A process for preventing the decay of wood, by filling the pores with a solution of corrosive sublimate. (Century)

Kyschtymite. A name derived from the Kyschtym mining district of the Urals, and given by J. Morozewicz to a rock consisting chiefly of anorthosite and corundum, with which are associated biotite, spinel, zircon, apatite, and, as secondary minerals, muscovite, chlorite, kaolin, and chromite. (Kemp)

L.

Laberinto (Sp. Am.). 1. Series of sand receptacles. (Lucas)
2. Confused, irregular workings. (Halse)

Labor. 1. (Sp.). Labor; work; a working. This term is applied in mining to the work which is actually going on, and to the spaces which have been dug out. It includes galleries, cavities, and shafts. (Raymond)
2. A Mexican land measure. (Standard)

Labor and improvements. Labor performed or improvements made for development in such manner as to facilitate the extraction of the metals, though such labor and improvements may not be on the particular location itself. (Smelting Co. *v.* Kemp, 104 United States, p. 651; Jackson *v.* Robey, 109 United States, p. 444; Justice Min. Co. *v.* Barclay, 82 Fed. Rept., p. 560; Anvil Hydraulic & Drainage Co. *v.* Code, 182 Fed. Rept., p. 206)

Laborant. A worker in a laboratory, as a chemist. (Webster)

Laborar (Port.). To work mines. (Halse)

Laboratory. 1. A place fitted up for chemical analysis, etc. 2. The space between the fire and flue bridges of a reverberatory furnace in which the work is performed; also called the kitchen and the hearth. (Raymond)

Laboratory furnace. A small, compact furnace such as the Bunsen burner furnace or the blast gas-furnace. (Century)

Laboreo (Sp.). Mining, or the act of mining. (Halse)

Laborer. 1. A man hired by the contract miner to assist him. 2. Mine laborer; a man working for day wages in or about a mine; a *company man* distinguished from digger or contractor. (Steel)

Labores (Sp.). A working place in a mine; a stall. *L. altas*, high workings, placers above water level; *L. á cielo*, an open-cut mine or quarry; *L. bajas*, low workings; *L. de cantera*, open-cast workings; *L. de crestón*, surface works (Lucas). *L. de hacienda*, all workings in a mine not let to tributers (Min. Jour.). *L. por cuadros*, pannel work; *L. por gradines*, stoping; *L. preparatorios*, dead works; *L. subterraneas*, underground workings. (Lucas)

Labradophyric. Containing distinct crystals of labradorite. Also called Labradoritic. (Standard)

Labrador feldspar-stone. Same as Labradorite. (Standard)

Labrador hornblende. Same as Hypersthene. (Standard)

Labradorite. A lime-soda feldspar. *See* Feldspar and Moonstone. (U. S. Geol. Surv.)

Labrar (Sp.). 1. To work a mine. 2. To work metals. 3. To dress stones. (Halse)

Labyrinth. 1. A series of canals through which a stream of water is directed for sorting crushed ore according to its specific gravity. (Webster)
2. A pipe or chamber of many turnings, for condensing vapors or fumes, as of mercury. (Standard)

Laccolite. A laccolith.

Laccolith; Laccolite. In geology, a mass of intrusive igneous rock, of approximately circular outline and lenticular cross-section with a flat base, which has been forced between strata so as to raise the overlying beds in the form of a dome. (La Forge)

Laces; Stoops; Nicks (Eng.). Lines cut, with the point of a pick, on slickensides. (Hunt)

Lacing. 1. (No. Staff.) Timbers placed across the tops of bars or caps to secure the roof between the timbers. Also called Lagging. 2. Strips or light bars of wrought iron bent over at the ends and wedged between the bars and the roof. (Gresley)

Lacolita (Sp.). Laccolith. (Dwight)

Lacustrine deposits. Deposits formed in the bottom of lakes. (Roy. Com.)

Ladder. 1. The arm which carries the tumblers and bucket line of a dredge. (Weatherbe)
2. An appliance of wood, metal, or rope, consisting of two long side pieces, usually parallel, with cross pieces on which a person may step on ascending or descending. (Webster)
3. (Som.) A wooden slide with cross bars on which hutches (boxes) run in steep seams. (Gresley)

Ladder dredge. A dredge having buckets carried on a ladder chain. (Century)

Ladder lode. Transverse fractures formed by the cooling of an eruptive dike and which have later become filed with ore. (Vogt, p. 65)

Ladder sollar. A platform at the bottom of each ladder in a series. (Standard)

Ladder vein. Deposits filling short transverse fissures sometimes occurring in dikes of intrusive rocks (Lindgren, p. 146). *See* also Ladder lode.

Ladderway; Ladder road. The particular shaft, or compartment of a shaft, containing ladders.

Lade. 1. (Scot.) A load. 2. A water course, ditch, or drain. 3. The mouth of a river. (Century)

Laded metal. Molten glass dipped from a melting pot to a casting table. Also called Gathered metal. (Standard)

Lade hole (Leic.). A shallow hole cut in the floor to receive the drainage. (Gresley)

Ladera. 1. (Sp.) Declivity. 2. (Mex.) Side track. (Halse)

Lading hole. In glass making, an orifice through which melted glass is ladled or taken out by a cuvette. (Standard)

Ladle. 1. A vessel into which molten metal is conveyed from the furnace or crucible, and from which it is poured into the molds. (Raymond)
2. In glass making, a cuvette. (Standard)

Ladle chaser. A man who distributes hot metal in ladles to different operations, keeps the hot-metal crew busy to prevent skulling of ladles and delay at the mill. (Willcox)

Ladle furnace. A small furnace for calcining or melting substances in a ladle. (Standard)

Ladle-house man. *See* Ladle liner.

Ladle liner. A man who lines, with brick, loam, and clay, ladle thimbles of hot-metal cars. (Willcox)

Ladle skuller. A laborer who removes rim and bottom skulls from hot-metal ladle cars. (Willcox)

Ladrillera (Sp.). An iron or stone mold for melting silver, to form the bar or ingot. (Crofut)

Ladrillo (Sp.). Brick; *L. de arcilla*, clay brick; *L. de fuego*, fire brick. (Halse)

Ladrón (Mex.). A robber. (Dwight)

Lafayette formation. A fluvioglacial deposit of reddish siliceous sand, from 40 to 200 feet thick, made in the Pleistocene during the first glacial retreat, over the Mississippi Valley to the Gulf, and along the Atlantic coast from Maryland to South Carolina. Formerly called Orange sand and Appomattox formation. (Standard)

Lag. 1. To provide or cover with lags; as, to lag a boiler with a nonconductor; to lag timbers in a mine (Standard). *See* Lags; *also* Lagging.
2. The time between a condition and the record of that condition made by any automatic recording device. 3. The amount of retardation of anything, as of a valve in opening or closing, or a metal in recovering its microstructure during a change in temperature.

Laga; Lages (Braz.). Loose masses of thin, flaggy rocks, considered as an indication of manganese ore near the surface. (Halse)

Lag bolt. *See* Lag screw.

Lagging. 1. Planks, slabs, or small timbers placed over the caps or behind the posts of the timbering, not to carry the main weight, but to form a ceiling or a wall, preventing fragments of rock from falling through. (Raymond)
2. Heavy planks or timbers used to support the roof of a mine, or for floors of working places, and for the accumulation of rock and earth in

a stope. (Northern *v.* Boston & Montana, etc., Min. Co., 190 Fed. Rept., p. 722)
3. Long pieces of timbers closely fitted together and fastened to the drum rings to form a surface for the rope to wind on. (Steel)
4. The narrow strips supporting an arch of masonry while in construction. (Standard)

Lag machine. A machine for fashioning wooden lags or lagging. (Standard)

Lago (Sp.). A lake; *L. salado*, a salt lake or marsh. (Halse)

Lagoon. 1. A marsh, shallow pond, or lake, especially one into which the sea flows. (Thompson)
2. A depression in the high, grass-covered table-lands of the western Cordilleras of the United States; typically without outlet, but not like 'kettle holes' in glacial deposits. 3. The basin of an Italian hot spring. (Standard)

Lagre (Fr.). In sheet-glass manufacture, a sheet of perfectly smooth glass, interposed between the flattening stone and the cylinder that is to be flattened. (Standard)

Lags (Eng.). Long pieces of timber closely fitted together and fastened to oak curbs or rings forming part of a drum used in sinking through quicksand or soft ground. (Gresley)

Lag screw. 1. A heavy round-shanked wood screw having usually a square head. 2. A flat-headed machine screw by which to fasten wood lagging, as on a curved surface. (Standard)

Laguna (Sp.). A lake or pond. (Halse)

Lagunato; Lagune (Mex.). A small lake. (Halse)

Laid out (Newc.). When a car or tub contains an excess of small coal or stones, it is forfeited, or *laid out* by the miner. (Min. Jour.)

Laigh (Scot.). Low, as laigh doors; laigh lift; laigh side; laigh level. (Barrowman)

Laired (Eng.). Choked with mud. (Bainbridge)

Lake. 1. An inland body of water or natural inclosed basin serving to drain the surrounding country, generally of considerable size and connected with the sea by a stream formed from its overflow. (Standard)
2. A pigment formed by absorbing animal, vegetal, or coal-tar coloring matter, from an aqueous solution by means of metallic bases. (Century)

Lake-bed placers (Alaska). Placers accumulated in the beds of present or ancient lakes; generally formed by landslides or glacial damming. (U. S. Geol. Surv., Bull. 259, p. 33)

Lake ore. *See* Bog iron ore.

Lake pitch. Asphalt from the Pitch Lake, Trinidad. It is richer than the land pitch in bituminous matter; soluble in petroleum spirit. (Bacon)

Lam; Lamb (War.). A kind of fire clay. (Gresley)

Lama (Mex.). 1. Literally, slime. The argentiferous mud which is treated by any amalgamation process; sometimes applied to tailings. Mud in vein. (Dwight)
2. Moist clay used by miners for sticking candles to their hats. 3. (Bol.) Rough pebbles forming a false bedrock to gold-bearing alluvial deposits, and known locally as lama-benches. (Halse)

Lamb. *See* Lam.

Lamb and slack (Canada). Refuse coal. (Morine)

Lambskin (Wales). Anthracite coal of inferior quality; culm. (Century)

Lame. 1. The bar to which the cutting edge of a chisel is attached. (Gresley)
2. Earthenware; a potsherd. Variation of loam. (Standard)

Lamellar. Composed of thin layers, plates, scales, or lamellæ; disposed in layers like the leaves of a book. (Standard)

Lamellar-stellate. In mineralogy, having or consisting of lamellæ arranged in groups resembling stars. (Standard)

Lamero (Mex.). A slime pit. (Halse)

Lame-skirting (Newc.). Widening a passage by cutting coal from the side of it (Raymond). Also called Skipping or Slicing.

Lametta (It.). Foil or wire of gold, silver or brass. (Standard)

Lámina (Sp.). 1. Thin plate or sheet of metal. 2. A screen used in gold milling. 3. A scale of gold. (Halse)

Laminable. Capable of being rolled or hammered into thin sheets; as, gold is the most *laminable* metal. (Standard)

Laminador (Sp.). A rolling mill. (Lucas)

Laminae. The thinnest separable layers or sheets in stratified rocks, whether (1) original planes of deposition, parallel or oblique, to the general stratification, or (2) in rarer usage, planes of cleavage transverse to stratification. (Standard)

Laminate. To beat, roll, or press into thin sheets, as a metal. (Standard)

Laminating machine. A set of rolls or any apparatus for making thin plates of metal, as for rolling gold, preliminary to beating. (Standard)

Laminating roller. The adjustable roller in a rolling mill whereby the thickness of rolled metal sheets are regulated. (Standard)

Lamination. Fine sedimentation planes within strata. (Lowe)

Laming process. A process for removing hydrogen sulphide and carbon dioxide from coal gas by passing it over a mixture of ferric hydroxide, lime, and cinders or sawdust. (Webster)

Lamings (No. of Eng.). A collier's term for accidents of almost every description to men and boys working in and about the mines (Gresley). A variation of Lame, to cripple or disable.

Lammie. A brick swelled out of shape in the kiln. (Standard)

Lamp. Any device employing a flame, incandescent wire, or the like, for furnishing an artificial light, or a similar device for heating, as in laboratory use (Standard). *See also* Safety lamp.

Lampa (Sp.). Shovel. (Lucas)

Lampadite, or cuprous manganese. A variety of wad containing 4 to 18 per cent of oxide of copper, and often oxide of cobalt also. (Dana)

Lampan (Malay). An open-cut hillside mine in which running water is used to remove the ore.

Lámpara (Sp.). A lamp; *L. del minero*, a miner's lamp; *L. de seguridad*, a safety lamp. (Halse)

Lampazo (Mex.). A sort of broom formed of green branches on the end of a long stick, to dampen the flame in a reverberatory furnace. (Dwight)

Lampblack. A product obtained directly from natural gas by burning the latter under plates or rolls. (Bacon)

Lamp cabin (Eng.). A place above ground, or underground near the pit bottom, where the safety lamps are repaired, cleaned, examined, lighted, and locked, before being handed to the workmen in cases where naked lights are not allowed to be taken from the bottom of the shaft. (G. C. Greenwell)

Lamp men. Cleaners, repairers, and those who have charge of the safety lamps at a colliery. (Gresley)

Lamp room. Same as Lamp cabin.

Lamprophyre. A general term, now used in a somewhat wider sense than as originally proposed by Gümbel, who suggested it. Rosenbusch, in the *Massigen Gesteine*, gave it its present significance. Lamprophyres are dike rocks of porphyritic texture, whose predominant phenocrysts are the dark silicates, augite, hornblende, or biotite. They are practically basic dikes. The word means a shining rock, and was first applied in 1874 to small dikes in the Fichtelgebirge that were rich in biotite. In a somewhat modified sense it has recently been employed by L. V. Pirsson, as a single term for the basic 'complementary rocks' (*see* Complementary rocks), and as the antithesis of oxyphyre, which applies to the acidic complementary rocks of an eruptive area. (Kemp)

Lamprophyric. In petrology, of fine-grained granophyric texture and characterized by phenocrysts of a dark silicate, such as biotite, hornblende, or augite. (La Forge)

Lamp stations (Eng.). Certain fixed places in a mine at which safety lamps are allowed to be opened and relighted (Gresley). A lamp room.

Lancashire bord-and-pillar system. *See* Bord-and-pillar method.

Lance. In founding, particularly in casting bomb-shells, an iron rod piercing through the mold and the core, for holding the latter firmly in place during the casting. (Standard)

Lancera (Mex.). An inclined stull. (Dwight)

Lanche (Peru). A kind of timber used in mines. Will last about 15 years. (Halse)

Land. 1. The exposed part of the earth's surface, as distinguished from the submerged part. 2. The rural regions. 3. The plane surface between the furrows of a millstone. (Century)
4. (Forest of Dean) Rising in the direction of the surface or outcropping. Workings to the rise of a drainage level. (Gresley)

Land asphalt. An inferior asphalt containing various impurities and lacking cementing qualities; from places outside of the Trinidad asphalt lake. (Power)

Land chain. A surveyor's chain of 100 links.

Land compass. A surveyor's circumferentor, or compass.

Land district. A division, of a State or Territory, created by law in which is located the land office for the disposition of the public lands therein. (United States *v.* Smith, 11 Fed. Rept, p. 491)

Land drainage. The act or process of freeing land from water. (Century)

Lander (Eng.). The man who receives the loaded bucket or tub at the mouth of the shaft (Gresley). Also called Banksman.

Lander's crook. A hook or tongs for upsetting the bucket of hoisted rock. (C. and M. M. P.)

Land fall. A land slide or land slip. (Century)

Land floe. A field of land ice. (Standard)

Land ice. 1. Ice formed on the land. 2. Ice along the shore or fast between headlands, as distinguished from floe ice. (Standard)

Landing. 1. A level stage for loading or unloading a cage or skip. 2. The top or bottom of a slope, shaft, or inclined plane. (Steel)
3. A platform from which to charge a furnace. (Standard)

Landing box (Scot.). The box into which a pump delivers water. (Barrowman)

Landings (So. Wales). Coal sent to the surface; the output. (Gresley)

Landing shaft (So. Wales). A shaft through which coal is raised. (Gresley)

Land pebbles. A Florida term for certain phosphatic pebbles, as distinguished from river-pebble phosphates. (Power)

Land pitch. Asphalt from the deposit in Trinidad lying between the Pitch Lake and the sea coast. (Bacon)

Land plaster. Any earthy or rock gypsum ground fine and used as a fertilizer. (Standard)

Land rock. *See* Phosphate rock; also called Land pebbles.

Landry box (Newc.). A box at the top of a set of pumps into which the water is delivered (Raymond). *See* Launder.

Land-sale (Eng.). Coal loaded into carts or wagons at the mine for local consumption. Also called Cart trade. (Gresley)

Land-sale colliery (No. of Eng.). A colliery situated in a remote district, being unconnected with rail, canal, or sea, and generally working thin or inferior seams. (Gresley)

Landscape marble. An argillaceous limestone presenting when polished representations of trees, rivers, and fortifications, caused by the infiltrations of oxide of iron. Also known as Forest, River, or Fortification marble, according to its markings. (Power)

Land sculpture. The carving out of the superficial features of the earth's surface by natural causes, as shore-waves, glaciers, and wind, and chiefly by rain and running water. Called also Earth sculpture. (Standard)

Landshut (Prov. Eng.). A landslide, or a landflood. (Standard)

Landslip. A portion of a hillside or sloping mass which becomes loosened or detached, and slips down. (Oldham) A landslide.

Landslip terrace. A short, rough-surfaced terrace resulting from the slip of a segment of a hill. (Standard)

Land surveying. The locating of the boundaries, area, characteristics, etc., of tracts of land. (Standard)

Land weight (Lanc.). The pressure exerted by the subsidence of the cover or overburden. (Gresley)

Lane mill. A low-speed edge-roller mill for fine crushing and amalgamating gold ore crushed by rolls and stamps. Similar to the Chilean mill.

Lang lay rope. A rope in which the wires in each strand are twisted in the same direction as the strands in the rope. (C. M. P.)

Langra (Bol.). A bunch or shoot of rich tin ore. (Halse)

Languedoc marble. A brilliant red or scarlet marble blotched with white; from the Montagne Noire, in the French Pyrenees. (Merrill)

Lantern. In founding, a core-barrel, comparatively short for its diameter. (Standard)

Lanthanite. A mineral, $La_2(CO_3)_3 + 9H_2O$, occurring in thin tabular crystals; also granular. earthy. Color grayish white, pink, yellowish. (Dana)

Lanthanum. A rare element allied to aluminum. Lead-gray and easily oxidizable. Symbol, La; atomic weight, 139.0; specific gravity, 6.15. (Webster)

Lanyon shield. An iron curtain, stiffened by ribs of angle iron, suspended from trolley wheels running on a rail parallel with and in front of a zinc furnace. Its main purpose is to protect the worker from the furnace heat. (Ingalls, p. 497)

Lap. One coil of rope upon a drum or pulley.. (Gresley)

Lapa (Braz.). Footwall (Halse). Also a cut driven into the footwall.

Lapidarist. A connoisseur of gems and precious stone, and the art of cutting and mounting them. (Webster)

Lapidary. An artificer who cuts, polishes, and engraves precious stones and gems. (Webster)

Lapilli. Volcanic dust and small ejectments, the results of explosive eruptions. (Kemp)

Lapilliform. Having the form of small stones. (Standard)

Lapis-lazuli. A translucent, rich berlin-blue, azure-blue, violet-blue, or greenish-blue stone used for ornament. It is a mixture of lazurite, hatiynite, and other blue minerals. (U. S. Geol. Surv.)

Lapis-lazuli ware. A variety of Wedgwood ware. *See also* Pebble ware.

Lapis ollaris. Soapstone, or talc, a hydrated silicate of magnesium. (Century)

Lápiz (Sp.). 1. Black lead, plumbago. 2. Black chalk; *L. encarnado*, red chalk, red ocher. 3. A black lead pencil. (Halse)

Lapizar (Sp.). A plumbago (graphite) mine or quarry. (Halse)

Lappior (Corn.). A miner who dresses refuse ore. (Min. Jour.)

Lapweld. To weld by overlapping the joints (Standard), as to *lapweld* iron pipe.

Laques (Peru). Water in a vein, as in vugs, or druses. (Halse)

Laramie group. A formation of the Cretaceous and Eocene Tertiary. (Standard)

Lardite. Agalmatolite. (Webster)

Lard stone. A kind of soft stone found in China. *See* Agalmatolite. (Century)

Large (Eng.). The largest lumps of coal sent to the surface, or all coal which is hand-picked or does not pass over screens; also the largest coal which passes over screens. (Gresley)

Larget. A piece of iron cut from a bar and ready to be heated and rolled into a sheet: about 14 pounds. (Standard)

Larguero (Mex.). Cap or side piece in shaft timbering. (Dwight)

Larry; Lorry. 1. A car to which an endless rope is attached, fixed at the inside end of the road, forming part of the appliance for taking up slack rope. *See* Barney. 2. A car with a hopper bottom and adjustable chutes for feeding coke ovens. (Steel)

Lashing. Any of a number of planks nailed inside of several frames or sets in a shaft to keep them together; also called Listing. (Webster)

Lasionite. Same as Wavellite. (Standard)

Lask; Lasque. A thin, flat diamond with a simple facet at the side. Called also Portrait stone. (Standard)

Lassenite. Wadsworth's name for unaltered, glassy trachytes. The name is derived from Lassen's Peak, Cal. (Kemp)

Last lift (No. of Eng.). The last rib or jud to come off a pillar. (Gresley)

Last of the air. 1. (Ark.) That part of the air current which has passed through all the workings of the mine or split; the outtake air. 2. (Ark.) The working place of a mine or split nearest the outtake of the air, or which receives the last of the air current. (Steel)

Latch. 1. (Eng.) To make an underground survey with a dial and chain; or to mark out upon the surface with the same instruments, the position of the workings underneath. (Gresley)
2. (Scot.) A miry place. (Century)

Latches. 1. A synonym for Switch. Applied to the split rail and hinged switches. (McNeil)
2. Hinged switch-points, or short pieces of rail that form rail crossings. (Junction Min. Co. *v.* Ench, 111 Illinois App., p. 348, 1903)

Latchings (Eng.). Diallings or surveys made at a mine (Gresley). *See also* Latch, 1.

Latent heat. The thermal equivalent of the energy expended in melting a unit mass of a solid or vaporizing a unit mass of a liquid; or conversely, the thermal equivalent of energy set free in the process of solidification or liquefaction. (Webster)

Lateral. 1. Belonging to the sides, or to one side. (Roy. Com.)
2. A horizontal mine working.

Lateral cleavage. Cleavage parallel to the lateral planes. (Webster)

Lateral crater. *See* Adventive crater.

Lateral moraine. A ridge of superficial débris collected from higher cliffs, on a lateral margin of a valley glacier (Standard). *See also* Moraine.

Lateral secretion. The theory that the contents of a vein or lode are derived from the adjacent wall rock. (Ore Dep., p. 40)

Lateral stress. A stress at right angles to the strain which produces it. (Century)

Laterite. A name derived from the Latin word for brick earth, and applied many years ago to the red, residual soils, or surface products, that have originated *in situ* from the atmospheric weathering of rocks. They are especially characteristic of the tropics. Though first applied to altered, basaltic rocks in India, laterite has had in later years a general application without regard to the character of the original rock. *Compare* Saprolite. (Kemp)

Lath. A board or plank sharpened at one end, like sheet piling, used in roofing levels or in protecting the sides of a shaft through a stratum of unstable earth (Webster). *See* Spill.

Lath door-set. A weak lath frame surrounding a main doorframe, the space between being for the insertion of spills. (Raymond)

Lathe! or **Laith!** (Mid.). "Lower the cage!" or, "Lower more rope!" (Gresley)

Lath frame, or crib. A weak lath frame, surrounding a main crib, the space between being for the insertion of piles. (Raymond)

Laths (Corn.). The boards or lagging put behind a frame of timber. (Raymond)

Latite. A name suggested by F. L. Ransome, for the rocks that are between the trachytes and andesites. Latite is meant to be a broad family name and to include the effusive representatives of the plutonic monzonites. Plagioclase and orthoclase are both present in about equal amounts; augite, hornblende, biotite, and olivine vary in relative amounts. The textures may be glassy, felsitic, or porphyritic. The name is derived from the Italian province of Latium but was suggested by studies on Table Mtn., Tuolumne Co., Cal. *Compare* Trachy-dolerite, Ciminite, Vulsinite, Monzonite. (Kemp)

Latitud (Sp.). 1. The distance from the Equator. 2. Breadth, width, or total extension. (Halse)

Latitude. 1. Distance on the earth's surface from the equator, measured in degrees of the meridian. 2. In surveying, the distance between two lines drawn east and west through the extremities of a course; northing or southing. (Standard)

Latón (Mex.). Brass; *L. blanco*, German silver; *L. en hojas*, sheet brass. (Halse)

Latrines. Water-closets either fixed or of a portable nature. The latter are often maintained underground for use of miners.

Latrobite. A pink anorthite from Labrador. (Standard)

Latten. Metal in thin sheets, especially (and originally) brass, which in this form is called also Latten-brass. (Standard)

Latten brass. A metallic compound into which scrap-brass and other ingredients enter, and which is rolled in thin plates. (Century)

Laubanite. A hydrous calcium aluminum silicate, $Ca_2Al_2Si_5O_{16}+6H_2O$. Resembles stilbite. A snow-white mineral. (Dana)

Laughing gas. Nitrous oxide, N_2O: so called as when inhaled it usually produces exhilaration, which is followed by insensibility. (Century)

Laumontite; Leonhardite; Caporcianite. A hydrous calcium aluminum silicate, $4H_2O.CaO.Al_2O_3.4SiO_2$. (Dana)

Laun. In ceramics, a fine silken sieve through which clay is passed. (Standard)

Launder. A trough, channel, or gutter, by which water is conveyed; specifically in mining, a chute or trough for conveying powdered ore, or for carrying water to or from the crushing apparatus. (Standard)

Laundry box. The box at the surface receiving the water pumped up from below. (Ihlseng)

Laurdalite. A coasely crystalline variety of nephelite-syenite, that is abnormal in having for its feldspar natron-orthoclase, rarely natron-microline, instead of the normal potash orthoclase. The dark silicates are biotite, diallage and olivine. (Kemp)

Laurentian. According to the U. S. Geological Survey, the younger of the two series of rocks comprised in the Archean system, consisting of Igneous rocks which in general underlie, but are intruded into and therefore younger than the rocks of the Keewatin series. Also the corresponding geologic epoch. (La Forge)

Laurvikite. A variety of augite-syenite that contains natron-orthoclase as its chief feldspar and most abundant mineral. The other components are rare plagioclase, pyroxene, biotite, barkevikite or arfvedsonite, olivine, and magnetite. Besides microscopic accessories, nephelite is occasionally present. *Compare* Pulaskite. (Kemp)

Lava. A general name for the molten outpourings of volcanoes. (Kemp) Fluid rock as that which issues from a volcano or a fissure in the earth's surface; also the same material solidified by cooling. It is commonly regarded as a molten rock, but more exactly it is mineral matter dissolved in mineral matter, the solution taking place at high temperatures only. (Webster)

Lava cone. A volcanic cone composed wholly of lava. (Daly, p. 185)

Lavadero (Mex.). 1. Literally, a washing place. A tank with stirring arrangement, to loosen the argentiferous mud from the *patio*, and dilute it with water, so that the silver amalgam may have a chance to settle. An agitator. 2. Placer deposit. (Dwight)
3. The act of washing or dressing ores. *L. de oro*, a gold-washer; an alluvial gold-washing. (Halse)

Lavador (Mex.). 1. A rod, used in drilling, to keep a wet hole clean. The rod is made by striking the end of a long fibrous stick against a harder substance until it is flat and soft. (Dwight)
2. A man employed in cleansing amalgam; an ore-washer. (Halse)

Lava flow; Lava stream. A stream of lava, whether flowing or congealed. (Webster)

Lava millstone. A hard, coarse, basaltic millstone from the neighborhood of the Rhine. (Webster)

Lava pit. A crater that is visibly floored with massive lava, either liquid or solid. (Daly, p. 141)

Lavar. 1. (Sp.) To wash ores, etc. 2. (Colom.) To collect and work the whole product of an alluvial mine. (Halse)

Lava streak. A dike of lava intersecting other rocks. (Standard)

Lavatic. Consisting of or resembling lava. (Standard)

Lavatorio; Lave (Mex.). In the *patio* process, washing the *torta*. (Halse)

Lavatory. A place where gold is obtained by washing. (Standard)

Lava ware. Various coarse articles and utensils made from iron slag, resembling lava in appearance. (Standard)

Lave (Scot.). To raise water out of a hole with a shovel or the hands. (Barrowman)

Lavic. Same as lavatic.

Lavour (Fr.). A vat for washing ore (Davies). *See* Buddle.

Lavra (Brazil). A small alluvial washing. (Lock)

Lavrovite. A pyroxene, colored green by vanadium. (Standard)

Lawn. Same as Laun.

Law of gravitation. The law, discovered by Sir Isaac Newton, that every body attracts every other body with a force that varies directly as the product of the masses of the two bodies under consideration and inversely as the square of the distance between them. (Standard)

Law of mass action. The law that the chemical action of a reacting substance is proportional at any moment to its active mass. (Webster)

Law of superposition. The law that underlying strata must be older than overlying strata where there has been neither inversion nor overthrust. Upon this law all geological chronology is based. (Standard)

Laxite. Wadsworth's name for the fragmental or mechanical rocks, especially when unconsolidated. (Kemp)

Lay. 1. The direction, or length, of twist of the wires and strands in a rope. (C. M. P.)
2. (Prov. Eng.) A standard of fineness for metals. 3. To close or withdraw from work: said of collieries. (Standard)
4. A share of profit; specifically, in whaling and sealing, the proportionate share of the profits of a voyage which each officer or member of the crew receives (Century). This term has been introduced into Alaska placer mining where it means a lease worked on shares or royalty. As a *lay* on No. 5 Glacier creek.

Lay-by (Joplin, Mo.). An underground siding at or near a shaft for storing empty mine cars.

Lay day (Scot.). *See* Lie time.

Layer. A bed or stratum of rock. (Buckley)

Layered (No. of Eng.). Choked up with sediment or mud. (Gresley)

Layme (Scot.). Earthenware; lame. (Standard)

Lay operations (Alaska). Mining on a lease or "lay" on an alluvial claim, for which the operator pays the owner a royalty up to 50 per cent on the gross output. *Compare* Lay, 4.

Lay operator (Alaska). A miner who takes a lease or "lay" on an alluvial claim.

Lay out (No. of Eng.). To set out, or put on one side, trams of coal, etc., that have been improperly filled. (Gresley)

Lazada (Sp.). A slip knot. A running noose. (Halse)

Lazadores; Enlazadores (Mex.). Men formerly employed in recruiting Indians for work in the mines, by the process of lassoing them. (Dwight)

Lazo (Sp.). 1. A bow; a slip knot. 2. Lasso; a light cord of fiber. (Halse)

Lazuli. Same as Lapis lazuli.

Lazulite. A hydrous, aluminum phosphate, with varying proportions of iron and magnesium, $(FeMg)O.Al_2O_3.P_2O_5.H_2O$. The mineral is azure blue, usually in pyramidal crystals; also massive. Used as an ornamental stone. (U. S. Geol. Surv.)

Lazulitic. Of, pertaining to, or having the characteristics of lazulite; applied to rocks. (Standard)

Lazurfeldspar. A blue variety of orthoclase, found in Siberia. (Chester)

Lazurite. A sodium aluminum silicate mineral containing sulphur, $Na_4(NaS_3Al)Al_3(SiO_4)_3$, a constituent of lapis lazuli. (Webster)

Lazyback (So. Staff.). The place at the surface where coal is stacked for sale. (Raymond)

Lazy balk (Eng.). A timber placed at the top of a hopper, against which the top of the car strikes in dumping, to prevent the car from falling into the hopper. (G. C. Greenwell)

Lazy kiln (Scot.). A limekiln in which the whole contents are calcined and afterwards removed before refilling. (Barrowman)

Leach. To wash or drain by percolation. To dissolve minerals or metals out of the ore, as by the use of cyanide or chlorine solutions, acids, or water.

Leach hole. A crevice created in land or rock by the action of leaching or constant filtration; a hole or outlet formed in land by the process of percolation (Standard). Also called Sink, or Sink hole.

Leaching. The process of separating metal from salts by treatment with a solvent (Skinner). *See* Lixiviation.

Lead (pronounced *leed*). 1. Commonly used as a synonym for ledge or lode. Many mining location notices describe the locator's claim as extending a certain number of feet along and so many feet on each side of the "lode, *lead*, vein or ledge." Thus Lead, S. Dak., was so named because of the Homestake "lead." *Blind lead:* A lead or vein that does not outcrop or show at the surface. Used especially at Virginia City, Nev. *Compare* Lode. 2. Properly, placer gravels. *Blue lead:* A Tertiary river channel at Placerville, Cal. So called because of the bluish-gray color of the gravels. *Deep lead:* Gold-bearing gravels deeply covered with débris or lava; applied particularly to those of Victoria, Australia. (Frank S. Hess). *See also* Lode.
3. (Penn.) A portion of a haulage system covered by a mule or by a locomotive of a maximum distance of, say, three-quarters of a mile. 4. (Eng.) To haul or draw coal, etc., either by animal or engine power. (Gresley)

Lead. 1. A metallic element, heavy, pliable, and inelastic, having a bright, bluish color, but easily tarnished to a dull gray. Symbol, Pb; atomic weight, 207.20; specific gravity, 11.4. (Webster)
2. In ceramics, to glaze with powdered metallic lead ore. (Standard)
3. The amount a steam valve is open when a reciprocating engine is on dead center.

Leadage. The distance coal must be hauled from the mine to its place of shipment. (Standard)

Lead ash. The slag of lead. (Standard)

Lead bath. A furnace in which gold or silver ores are smelted with lead. (Standard)

Lead colic. A violent form of intestinal colic, associated with obstinate constipation, produced by chronic lead poisoning. Painter's colic. (Webster)

Lead encephalopathy. The medical term for lead poisoning.

Leader. 1. A cast- or wrought-iron ring or shoe, bolted to the bottom (often around the outside) of a brick cylinder, a wooden drum, or a wrought-iron cylinder when used for sinking through quicksand or gravel. 2. (Som.) The slip of a fault. 3. Any particular or constant bed or band of coal, ironstone, etc., in connection with certain workable beds, serving as a datum line in a mine. 4. (No. of Eng.) A back or fissure in a coal seam. (Gresley)
5. (Scot.) One who conducts the putting down of a borehole. (Barrowman)
6. (Corn.) A small vein leading to a larger one. (Raymond)

Leader of the lode (Eng.). *See* Leader, 6.

Lead fume. The fume escaping from lead furnaces, and containing both volatilized and mechanically suspended metalliferous compounds. (Raymond)

Lead glance. Same as Galenite; lead sulphide.

Lead glaze. *See* Lead, 2.

Leadhillite. A monoclinic mineral of a yellowish or greenish color consisting of a sulphate and carbonate of lead, perhaps $4PbO.SO_3.2CO_2.H_2O$. (Dana)

Leading (Aust.). The unprofitable gravel above gold-bearing sand. (Skinner)

Leading band (York.). A heading about 18 yards wide driven to the rise and between a pair of bordgates. (Gresley)

Leading bank (York.). A breadth of about 18 yards of coal taken out to the rise between pairs of bordgates

Leading frames (Eng.). In tunnel work, frames formed to the contour of the invert and the walls, to guide the bricklayers. (Simms)

Leading lengths. *See* Lengths.

Leading man. *See* First man.

Leading place (Scot.). A working place in advance of the others, such as a heading or a level. (Barrowman)

Leadings (1) (Derb.). Small sparry veins in the rock (Min. Jour.). Same as Leader, 3.

Leading winning (Aust.). A heading in advance of the ordinary bords (Power). A leading bank.

Leading wire. A cotton-covered copper wire, usually No. 14 gauge, used for connecting the two free ends of the circuit of the electric blasting caps, in the blast, to the blasting machine. (Du Pont)

Lead lap. 1. A gem-cutter's lap of lead, copper, or iron; also, the entire machine. (Standard)
2. In mechanics, a lap of lead charged with emery and oil. (Webster)

Lead luster. Lead oxide, used as a glaze for ceramic ware. (Standard)

Lead marcasite. A variety of sphalerite, called by miners Blende, Mock lead, or Mock ore.

Lead mill. A leaden disk charged with emery for grinding gems. (Standard)

Lead ocher. Massicot or lead monoxide, PbO. Massive, scaly, or earthy. Color yellow, reddish. (Dana)

Lead palsy. Paralysis due to lead poisoning. (Webster)

Lead paralysis. Paralysis resulting from lead poisoning. (Standard)

Lead poisoning. A morbid condition produced by the cumulative introduction of lead into the system. (Standard)

Lead reeve (Eng.). An officer before whom aggrieved miners lodge their complaints (Standard). A mine foreman.

Lead spar. 1. (Corn.) Anglesite. (Raymond)
2. Cerusite (Standard). The term "spar" is common among miners, and applies to any of the metallic minerals which are cleavable and lustrous.

Lead tree. A crystalline deposit of metallic lead on zinc that has been placed in a solution of acetate of lead. (Standard)

Lead vitriol. Same as Anglesite. (Standard)

Lead works. A place where lead is extracted from the ore. (Century)

Leaf. A very thin sheet or plate of metal, as gold. (Standard)

Lean. Applied to poor ores, or those containing a lower proportion of metal than is usually worked. (Roy. Com.)

Leap (Eng.). A dislocation of strata by faulting. *See* Down-leap and Up-leap. (Gresley)

Leap ore. Tin ore of the poorest quality. (Standard)

Learies (Eng.). Empty places; old workings. (Bainbridge)

Lease. 1. A contract for the possession and profits of lands for a determinate period, in consideration of a recompense of rent. 2. The instrument by which such grant is made. 3. A piece of land leased for mining purposes.

Leaser. A Western colloquialism meaning lessee.

Lea stone (Lanc.). Laminated sandstone. (Gresley)

Leat (Corn.). A watercourse. (Raymond)

Leath (Derb.). The soft part of a vein. (Raymond)

Leather bed (Mid.). A tough leather-like clayey substance in a fault slip, composed of the crushed and fractured ends of the coal measures. (Gresley)

Leather jacket (Aust.). A Ballarat name for clay occurring in cross-courses. (Power)

Leather lap. A disk covered with leather for polishing gems. (Standard)

Leatherstone. A synonym for Mountain leather. (Chester)

Leaving (Corn.). The mineral left after the good ore has been removed (Raymond). Tailings.

Le Blanc process. A process in which, in the manufacture of sodium carbonate (soda-ash), the sodium sulphate, called *salt cake* (made by heating salt with sulphuric acid), is reduced to sodium sulphide by heating with charcoal and limestone, which then yields the impure sodium carbonate called *blackball* or *black-ash*. (Standard)

Lecho (Sp.). 1. A bed; bed of a river. 2. A thin layer or stratum. 3. A smelting mixture as distinguished from fuel. (Halse)

Lechoso (Mex.). Milky; a variety of opal. (Dwight)

Leck. A thick, stony clay. Called also Lack or Leck clay. (Standard)

Leckstone. A granular variety of trap found in Scotland; used for the bottoms of ovens. (Standard)

Led (No. of Eng.). A spare tub, or one that is being loaded while another is being emptied. (Gresley)

Lederite. A brown variety of titanite. (Standard)

Ledge. 1. In mining, ledge is a common name in the Cordilleran region for the lode or for any outcrop supposed to be that of a mineral deposit or vein. It is frequently used to designate a quartz vein (Century). A lode; a limited mass of rock bearing valuable mineral (Webster). *See also* Vein.
2. The term ledge is ordinarily applied to several beds of rock occurring in a quarry. In some instances, however, the term is applied to a single bed. (Buckley)

Ledger (Eng.). Applied to the lower side of a vein. (Bainbridge)

Ledge rock. The true bedrock; distinguished from bowlders or rock that has been moved. (Standard)

Ledger wall. Same as Footwall.

Leelite. A flesh-red variety of orthoclase. (Standard)

Lee process. A process for shaping any of the softer metals or alloys, by simply squeezing it cold through or into a suitably shaped hole. Called also Extrusion or Squirting process. (Webster)

Leer. A small furnace for annealing flint glass. (Ure)

Leering. In glass making, the process of treating in the annealing oven or leer. (Standard)

Lee side. In geology, that side of glaciated rocks that looks away from the quarter whence the ice moves, or moved, as indicated by rough and weathered surfaces: opposed to Shock side or Stoss side. (Standard)

Leet. A stack of peat, properly 24 feet long by 12 feet wide and 12 feet high. (Standard)

Leg. 1. A prop of timber supporting the end of a stull, or cap of a set of timber. (Raymond)
2. (Eng.) A stone that has to be wedged out from beneath a larger one. (Gresley)

Legal geology. *See* Geology.

Legón (Sp.). A small scraping shovel or scraper used underground. (Halse)

Leg piece. The upright timber that supports the cap piece in a mine. (C. and M. M. P.)

Legs. 1. (Aust.) The two sides or wings of a saddle reef or anticline. (Power)
2. The wires attached to and forming a part of an electric blasting cap. (Du Pont)
3. The uprights of a set of mine timbers. *See also* Leg piece.

Legua (Mex.). League; equal to 2.604 English miles or 4.19 kilometers. One square league is called *sitio de ganado mayor*, and is equal to 4338.1123 acres. (Dwight)

Lehm. Same as Loess. (Standard)

Leip (Scot.). *See* Lipe.

Leito (Port.), **Lecho** (Sp.). Bed of a river. (Halse)

Lémnian earth. A variety of clay or aluminous earth, so called from the Island of Lemnos in the Ægean Sea. (Page)

Lemnian reddle (Eng.). An ocher of a deep-red color, occurring in conjunction with the Lemnian earth, and used as a pigment. (Page)

Leña (Mex.). Fuel wood. (Dwight)

Leñador; Leñero (Mex.). Cutter, carrier, or supplier of fuel wood. (Dwight)

Lencheon (Eng.). A shelf of thin rock in a mine shaft. (Bainbridge)

Lengthening rod. A screwed extension rod for prolonging a well-boring auger or bit. (Standard)

Length of shot. The depth of the hole in which the powder is placed, or the size of the block of coal to be loosened by a single blast measured parallel with the hole. (Steel)

Lengths (Eng.). In tunnel construction the successive sections in which a tunnel is executed. *Shaft lengths* are directly under the working shaft; *Side lengths* are on each side of the shaft length; *Leading lengths* are prolongations of the tunnel from the side lengths; *Junction lengths*, which complete the portion of the tunnel extending between two shafts, or between a shaft and an entrance. (Simms)

Lengua (Colom.). That portion of gold which forms in the shape of a tongue when panning. (Halse)

Lengüebuey (Sp. Am.). A tongue-shaped rock. (Lucas)

Lens. A body of ore or rock thick in the middle and thin at the edges; similar to a double convex lens. *See* Lenticular.

Lente (Sp.). 1. Lens. 2. A lenticular mass of rock or ore. (Halse)

Lenticle. A rock stratum or bed, whether large or small, which, from being thin at the edges, is more or less lens-shaped. (Standard)

Lenticular. Shaped approximately like a double convex lens. When a mass of rock thins out from the center to a thin edge all around, it is said to be lenticular in form (Roy. Com.). *See also* Lens.

Lenticule. A small lens-shaped body in a rock-mass. (Standard)

Lentille. An isolated mass of rock containing fossils of a fauna older than the strata in which it occurs, though of contemporary age with those strata. (Winchell)

Lentil. In geology, a lenticular subdivision of a formation. (La Forge)

Lentils. A short name for lenticular beds in a stratified series. (Kemp)

Leopardite. A siliceous rock from North Carolina, spotted with stains of manganese oxide. It is usually considered to be a quartz-porphyry. (Kemp)

Leopard rock. A local name in Canada, applied to pegmatitic rocks that are associated with the apatite veins of Ontario and Quebec. (Kemp)

Leopoldi furnace. A furnace for roasting quicksilver ores, differing from the Bustamente in having a series of brick condensing chambers. Both are intermittent, *i. e.*, have to be charged and fired anew after each operation. The Californian intermittent furnace is a modification of the Leopoldi, having the fireplace on the side. (Raymond)

Lepanto marble. A trade name given to a gray marble enlivened by pink and white fossils; from the Lower Silurian, near Plattsburg, New York. (Merrill)

Lepidolite. A light-colored (pearly, rose-red, violet-gray, lilac, yellowish) lithium-bearing mica. Contains from 3.9 to 5.9 per cent lithia, Li_2O.

Lepidomelane. A mineral, near biotite, but characterized by the presence of a large amount of ferric iron. (Dana)

Leppey (Eng.). Work that is easy, "soft, kind, and winable, without any hardship, as boring, cutting, blasting," etc. (Hunt)

Leptinite; Leptynite. The French synonym for granulite. *See* Granulite (Kemp). *Compare* Whitestone, 2.

Leptoclase. Daubrée's term for minor fractures. (Power)

Leptometer. A specially constructed viscometer, invented by Lepenau. (Mitzakis)

Leptomorphic. A term suggested by Gümbel for crystallized substances that lack definite crystalline borders, as the nephelite in many groundmasses. (Kemp)

Lestiwarite. A name proposed by Rosenbusch for the aplitic dike-rocks that accompany nephelite-syenites in Norway and Finland. They are chiefly or almost entirely alkali feldspar, with very subordinate pyroxene or amphibole. They had been previously called syenite-aplites by W. C. Brögger. Lestiwarite is derived from the Finnish locality Lestiware. (Kemp)

Leuchtenbergite. A variety of clinochlore, white, pale green, or yellowish in color, containing little or no iron; often resembles talc. (Dana)

Leucite. A silicate of potassium and aluminum, $KAl(SiO_3)_2$. The name of the mineral is prefixed to names of many rocks that contain it, as, leucite-absarokite, leucite-syenite, etc. (Kemp)

Leucite-basalt. Basaltic rocks with olivine, in which leucite replaces plagioclase. (Kemp)

Leucite-basanite. Basaltic rocks that contain both leucite and plagioclase. As contrasted with leucite-tephrites, they contain olivine. (Kemp)

Leucite-tephrite. Basaltic rocks without olivine, that contain both plagioclase and leucite. *Compare* Leucite-basanite. (Kemp)

Leucitic. Of, or pertaining to leucite; containing or resembling leucite. (Century)

Leucitite. Basaltic rocks without olivine in which leucite replaces plagioclase. *Compare* Leucite-basalt. (Kemp)

Leucitophyre. A name formerly used for the leucite rocks, but now by common consent restricted to those phonolites that contain both leucite and nephelite. (Kemp)

Leucochalcite. A hydrous arsenate of copper, usually found in white, or greenish, silky, needle-like crystals.

Leucocratic. In petrology, characterized by the dominance of light-colored minerals, like quartz, the feldspars, and muscovite: said of some igneous rocks and contrasted with melanocratic. (La Forge). Leucocratic is derived from two Greek words meaning "white prevails."

Leucopetrite. A substance, between a resin and wax in character, found in a brown coal at Gesterwitz, near Weissenfels; it crystallizes in white needles from ether and boiling absolute alcohol, and melts above 100° C. (Bacon)

Leucophyre. In petrology, a light-colored, felsitic, igneous rock. (La Forge). Originally applied by Gümbel in 1874 to light-colored diabases whose feldspar was altered to saussurite and whose augite had largely changed to chlorite. Rosenbusch restricts it to diabases poor in plagioclase. The name means a light-colored or white porphyritic rock, and has little claim to consideration either in etymology or application. (Kemp)

Leucopyrite. *See* Löllingite.

Levantamiento (Sp.). 1. Elevation. 2. An upheaval. 3. In coal mining, creep. (Halse)

Levantar planos (Sp.). To survey. (Dwight)

Levante. 1. (Mex.). Breast of a stope. *Al levante*, overhand stoping. (Dwight)
2. The operation of taking up the tubes and lines of *aludeles* in order to clean them out and collect the mercury. (Halse)

Levanto (Peru). The removal of the mud heap, after standing for a week, following the addition of the mercury. (Halse)

Levee. An embankment beside a river or stream or an arm of the sea, to prevent overflow. (Standard)

Level. 1. A horizontal passage or drift into or in a mine. It is customary to work mines by levels at regular intervals in depth, numbered in their order below the adit or drainage level, if there be one (Raymond). Rarely applied to coal mining.
2. An instrument for finding a horizontal line or plane, or adjusting something with reference to a horizontal line. (Webster)
3. (Newc.) A gutter for the water to run in. (Min Jour.)

Level course (Scot.). In the direction of the strike of the strata, or at right angles to the dip and rise. (Barrowman)

Level-free. 1. (War.) Old coal or ironstone workings at the outcrop, worked by means of an adit driven into the hillside. (Gresley)
2. A mine that discharges water by gravitation. (Roy)

Leveling. In surveying, the operation of ascertaining the comparative levels of different points of land, for the purpose of laying out a grade, etc., by sighting through a leveling instrument at one point to a leveling staff at another point. (Standard)

Leveling instrument. A surveyor's level bearing a telescope. (Standard). *See* Level, 2.

Leveling pole, rod, staff. *See* Level rod.

Level rod. A graduated rod used in measuring the distance between points on the ground and the line of sight of a leveling instrument. (Webster)

Level stones (Scot.). Stones on the surface of the ground indicating the direction of old levels underground. (Barrowman)

Level tons (Eng.). A weight of mineral in even tons, any odd cwts. not being taken into account. (Gresley)

Leveret skin. A Japanese glaze applied to ceramic ware, supposed to resemble a leveret's fur. (Standard)

Leverman. One who operates brakes, or levers, at the top of an incline plane. A brakeman.

Levigation. A rubbing down to a powder. Levigation is distinguished from trituration by being done with water, while the latter is the dry method. (Oldham)

Levitation. The act of rendering light or buoyant. Latin, *levitas*, lightness, from *levis*, light. (Rickard)

Lewis. An iron device in the shape of a dove-tailed tenon, made of several parts, inserted into a dove-tail mortise in a large stone, for the purpose of attaching a hoisting apparatus. (Standard)

Lewis bolt. A wedge-shaped bolt fastened in a socket by pouring in melted lead, and used in raising a heavy block, as of stone. (Standard). *Compare* Lewis pin.

Lewis hole. 1. A series of two or more holes drilled as closely together as possible, but then conected by knocking out the thin partition between them, forming thus one wide hole, having its greatest diameter in a plane with the desired rift. Blasts from such holes are wedgelike in their action, and by means of them larger and better-shaped blocks can be taken out than would otherwise be possible. (Merrill)
2. A dove-tail mortise, as in a block of stone, for attaching a lewis for hoisting. (Standard)

Lewis pin. A pin used for attachment to a key block. It is placed in a shallow drill hole with a wedge at either side, and as the pin is larger at the bottom than near the top, when it is pulled upward it tends to tighten on the wedges, which prevents it from slipping out. (Bowles)

Ley (Sp.). 1. Literally, law; *L. de minas*, law of mines. 2. In mining, the proportion of precious and other metals in any mineral compound. Grade of ore (Dwight). *L. de oro*, quantity of gold contained in the silver. *L. de plata*, quantity of silver contained in the ore (Min. Jour.). *L. media*, average grade.

Ley de oro (Mex.). Properly the fineness of the gold, but apparently also applied to the assay-value of an ore. (Lock)

Leg pewter. A low-grade pewter having an excessive proportion of lead. (Standard)

Leys; Blue leys (Lanc.). Same as Bind, 1.

Lherzolite. A variety of peridotite, containing olivine, diopside, and an orthorhombic pyroxene. (Kemp)

Lias. 1. The oldest and lowest of the series comprised in the Jurassic system of strata in Europe. (La Forge)
2. A lithographic stone. (Ure)

Liassic. Belonging to the geological subdivision of the Jurassic called the Lias (Century). *See* Lias, 1.

Liber. An iron shaft by which a horse draws a number of cars in a coal mine (Standard). An erroneous spelling of "Limber," *which see.*

Libethenite. An olive-green to dark green hydrous basic phosphate of copper, $Cu_2(PO_4)_2.Cu(OH)_2$. (Dana)

Libollite. A kind of asphalt occurring near Libollo, in western Africa; it resembles albertite. (Bacon)

Libramiento (Sp.). Warrant for payment for bars of gold or silver delivered at the mint, or order for funds. (Min. Jour.)

Libranza (Sp.). A bill of exchange; a draft or check. (Halse)

Libreta (Sp.). 1. A surveyor's notebook. 2. *L. de mina*, a mine notebook. (Halse)

Libro (Sp.). A book; *L. de agrimensor*, a surveyor's field book. (Halse)

Lick. A swampy area surrounding a salt spring, the soil of which is licked up by animals frequenting it. (Oldham)

Licuación (Mex.). Liquation. (Dwight)

Lid. 1. (Eng.) A flat piece of wood placed between the end of a prop or stempel and the rock. (Raymond)
2. (Forest of Dean). The roof of an ironstone working. (Gresley)
3. (Scot.). The cover or flap of a valve. (Barrowman)
4. A cross-beam on an upright prop. (Standard)

Lidded (Eng.). Applied to the contracted top of a pipe vein. (Bainbridge)

Lidstone (Forest of Dean). The roofstone of an iron mine. (Gresley)

Lie. 1. (Scot.) To become quiet or inactive (Century). Said of a mine that is idle.
2. (Scot.) The line, direction, or bearing as of a vein, lode, or fault.

Lie! or Lie up! (Scot.). In mine haulage, a command to stop. (Barrowman)

Liebenerite - porphyry. Nephelite - porphyry whose nephelite phenocrysts are altered to muscovite. Its original locality is near Predazzo, in the Tyrol. *Compare* Gieseckite - porphyry. (Kemp)

Lie days (Scot.). *See* Lie time, 1.

Liège furnace. *See* Belgian zinc furnace; *also* Belgian process.

Lie key (Scot.). A tool on which boring rods are hung when being raised or lowered in a borehole. (Barrowman)

Lie time. 1. (Scot.) The time for making up accounts preceding each pay day in which work has been done, but payment for which has to remain or lie over till next pay day. (Barrowman)
2. (Scot.) A period of rest or cessation from work during a shift or turn. (Gresley)

Lievrite. *See* Ilvaite.

Life. When in cutting or getting coal it makes a crackling or bursting noise and works easily, it is said to have life in it, or to be alive. (Gresley)

Lift. 1. The vertical height traveled by a cage in a shaft. 2. The *lift of a pump* is the vertical distance from the level of the water in the sump to the point of discharge. 3. The distance between the first level and the surface, or between any two levels. 4. Any of the various gangways from which coal is raised at a slope colliery. The term originally referred to the number of pump lifts, but in the anthracite regions its significance has become broader. (Chance)
5. (Scot.) A set of pumps from the suction to the delivery box; the uppermost set is called the lift, the lowest the bottom or laigh lift. (Barrowman)
6. (Aust.) A slice taken off a pillar when winning it. (Power)
7. A certain thickness of coal worked in one operation. 8. (No. of Eng.) To clear gas out of a working place. 9. To creep, as when the floor rises or lifts. 10. A broken jud. 11. (Penn.) A block of coal measuring three-quarters of a mile on the strike by 1,000 yards to the rise. 12. (Forest of Dean) A rise in the price of coal or in miners' wages. 13. To break up, bench, or blast coal from the bottom of the seam upward. 14. A certain vertical thickness of coal seams and measures, having considerable inclination, between or in which the workings are being carried on to the rise, all the coal being raised from one shaft bottom. (Gresley)
15. The plane approximately parallel with the floor of the quarry, along which the stone is usually split in quarrying. (Buckley)

Lifter. 1. (Eng.). The stem of iron or wood attached to the stamp-head. (Hunt)
2. Any of the boreholes for blasting that are drilled horizontally or nearly so and usually at about the floor level. (Du Pont)
3. A molder's tool for handling sand. (Standard)

Lift hammer. *See* Tilt hammer.

Lifting (Scot.). Drawing hutches (cars) out of the working places into the main roads. (Gresley)

Lifting dog. A claw hook for grasping a column of bore-rods while raising or lowering them. (Raymond)

Lifting guard. Fencing placed around the mouth of a shaft, and lifted out of the way by the ascending cage. (Steel)

Lifting set. A series of pumps or sets of pumps by which water is lifted from the mine in successive stages (Standard). *See* Lift, 5.

Lifting wicket (So. Wales). *See* Lifting guard.

Lift pump. A pump for lifting to its own level, as distinguished from a force pump (Standard). A suction pump.

Liga (Mex.). Alloy; lead flux for smelting dry ores; galena rich in silver. (Dwight)

Ligar (Sp.). To alloy gold or silver for coinage. (Halse)

Light coal (Scot.) Candle coal; gas coal, *which see.* (Barrowman)

Lightening. A peculiar brightening of molten silver, indicating that maximum purity has been attained (Standard). Occurs in cupellation. *See* Blick.

Lighting. In metallurgy, annealing. (Standard)

Light metal. A metal or alloy having a density of less than five times that of water. (Standard)

Lightning explosion (Eng.). An explosion of fire damp caused by an electric current, during a thunderstorm, entering a mine and igniting the gas. (Gresley)

Light, polarized. Light in which the vibrations are in one plane.

Light red silver ore. *See* Proustite.

Light ruby silver. *See* Proustite.

Lignite. A brownish-black coal in which the alteration of vegetal material has proceeded further than in peat but not so far as sub-bituminous coal. (U. S. Geol. Surv.)

Lignitic. Containing lignite.

Lignitic group. A lignitiferous series of sands and clays of the Cretaceous and Tertiary of the United States; the Laramie group (Standard). The term is now obsolete.

Lignitiferous. Lignite-bearing. (Standard)

Lignitize. To convert into lignite. (Century)

Lignito (Sp.). Lignite or brown coal. (Halse)

Ligurite. An apple-green variety of titanite. (Standard)

Likely. A belt of country or a lode is said to be likely when there are indications of valuable minerals; opposed to hungry. (Power)

Lilin Kalulut (Malay). A wax used by gold assayers. (Lock)

Lima (Mex.). File. (Dwight)

Limadura (Sp.). 1. Act of filing. 2. filings. 3. Refined silver from the *patio* process. 4. Silver amalgam in a finely divided condition. Floured mercury. (Halse)

Limb. 1. One of the two parts of an anticline or syncline on either side of the axis. *See* Legs, 1. 2. The graduated margin of an arc or circle in an instrument for measuring angles. 3. The graduated staff of a leveling rod. (Webster)

Limber; Limmer (Eng.). A light, wooden or iron shaft for attaching pit ponies to the trams. (Gresley)

Limburgite. A vitrophyric igneous rock, resembling basalt, containing olivine and augite in a glassy groundmass. The name is derived from Limburg, a locality on the Kaiserstuhl, a basaltic mountain in Baden. It was suggested by Rosenbusch in 1872, and at the same time Boricky described similar rocks from Bohemia as magmabasalt. (Kemp)

Lime. An alkaline earth consisting of the oxide of calcium. Artificially made by calcining or burning limestone or marble. Lime made from dolomitic limestone contains a considerable percentage of magnesia, and is slower setting (Frank L. Hess)

Lime burner. One who burns limestone, etc., to make lime. (Webster)

Lime cartridge. A charge or measured quantity of compressed dry caustic lime made up into a cartridge and used instead of gunpowder for breaking down coal. Water is applied to the cartridge, and the expansion breaks down the coal without producing a flame. (Steel)

Lime catcher. A filtering apparatus for extracting calcium salts from the feed water of a steam boiler, thus preventing the deposit of scale in the boiler. (Standard)

Lime coal (Scot.). Small coal used for burning lime, being one of the grades of coal in the east of Scotland in former times. (Barrowman)

Lime craig (Scot.). Limestone rock *in situ;* the face of a limestone quarry. (Barrowman)

Lime feldspar. *See* Anorthite.

Lime kiln. A kiln or furnace in which limestone or shells are burned and reduced to lime. (Webster)

Lime man. One who attends to slaking lime, running lime water to vats beneath pig-machine molds at blast furnaces, and operates lime sprays when the machine is running. (Willcox)

Lime pit. 1. A limestone quarry. 2. A pit where lime is made. 3. A pit where lime is used, as in liming hides. (Webster)

Lime powder. Air-slaked lime. (Webster)

Lime process. The method of mining coal by the use of the lime cartridge. (Gresley)

Limerickite. A very dark, violet, oölitic rock found in the meteorite of Oschausk. (Standard)

Lime rock. Any rock or stratum in which limestone is a prominent ingredient (Standard). Limestone.

Limeshells (Scot.). Calcined limestone. (Barrowman)

Limestone. The general name for sedimentary rocks composed essentially of calcium carbonate. (Kemp)

Limestone meter. An instrument for determining the proportion of calcareous matter in soils. (Century)

Limestone sink. A depression in the land surface in a limestone region, often communicating with a cavern or subterranean passage so that wa-

ter running into it is lost. Called also, Sink hole, Swallow hole. (Webster) Caused by the falling in of the roof of a cave, due to the solution and removal of limestone that supported the overburden.

Lime uranite. *See* Uranite.

Lime wash. To wash with a solution of lime; to whitewash. (Webster)

Lime wavellite. An impure variety of wavellite that contains calcium. (Standard)

Limmers (Newc.). The shafts by which the horses draw mine cars. (Min. Jour.). *See also* Limber.

Limnite. A yellow ocher or brown iron ore, containing more water than limonite. (Century)

Limo (Sp.). Slime; mud. (Halse)

Limonite. Brown, hydrous oxide of iron containing, when pure, 85.6 per cent of iron and 14.4 per cent of water. The mineral is earthy or of irregular form, never in distinct crystals. It is the usual product left behind in the oxidation of pyrite, chalcopyrite and other iron-bearing minerals. *See* Brown iron ore.

Limonitic. Consisting of limonite, or resembling it in appearance. (Century)

Limonitization. The process of altering to, or supplying with, limonite. (Standard)

Limp. A sheet-iron or wooden scraper, for removing poor ore from the top of a sieve (Standard). Spelled Limpeth in Derbyshire.

Limpeth. *See* Limp.

Limpia (Sp.). 1. Deads or low-grade ore. 2. Clearing out rubbish or waste from mine workings. (Halse)

Limpiador (Sp.). 1. An ore-sorter. 2. A tool for cleaning a borehole. (Halse)

Limpio (Sp.). 1. Clean; free. 2. Cobbed or picked ore. (Halse)

Limurite. A name for a rock consisting of axinite, pyroxene, amphibole, quartz, titanite, calcite, pyrite. and pyrrhotite. It occurs on the contact of granite and limestone, although formerly thought to be a member of the crystalline schists. (Kemp)

Linarite. A natural, hydrous, basic sulphate of lead and copper, $PbO.CuO.SO_3H_2O$. (U. S. Geol. Surv.)

Lind coal. Charcoal made of the wood of the linden tree. (Century)

Lindero (Sp.). Boundary or limit of a claim or mine. (Halse)

Lindöite. A quartz-bearing aplitic variety of syenite (La Forge). Brögger's name for certain dike rocks, in the region of Kristiana. They have trachytic texture; are seldom and then but slightly porphyritic; are medium to coarsely crystalline in the larger dikes; possess light colors and often lack dark-colored minerals. When such are recognizable they are pyrite and chlorite. Ferriferous carbonates are present. Traces of aegirite and of a dark, alkaline hornblende may be occasionally detected. (Kemp)

Line. 1. The limit of a surface; a length without breadth; outline; contour. 2. The course in which anything proceeds, or which any one takes; direction given or assured. 3. A unit of length, equal to one twelfth of an inch (Century). 4. *See* Plumb line.

Linea (Sp.). A line; *L. de base*, a base line in surveying; *L. de demarcación*, a boundary line. (Halse)

Lined gold. Gold foil backed with other metal. (Standard)

Lineman. 1. In surveying, a man who carries the tape line or chain (Standard). Also called Chainman.
2. One in charge of maintenance of light and power electric circuits at blast furnaces. Sometimes including switchboard; usually an "inspector" takes charge at the switchboard. (Willcox)

Line of bearing. The direction of the strike, or outcrop. (Thompson)

Line of dip. The line of greatest inclination of a stratum to the horizon. (Thompson)

Line of force. A straight line through the point of application of a force and in the direction of its action. (Century)

Line of tunnel. The width marked by the exterior lines or sides of a tunnel. (Corning Tunnel, etc., Co., *v.* Pell, 1 Colorado, p. 510)

Liner (Leic.). A bar put up between two other bars to assist in carrying the roof. (Gresley)

Lines. Plumb lines, not less than two in number, hung from hooks driven in wooden plugs. A line drawn

through the center of the two strings or wires, as the case may be, represents the bearing or course to be driven on. (Steel)

Lingot. 1. An iron ingot-mold. 2. An ingot, or something resembling one. (Standard)

Lingote (Sp.). An ingot; a mass of gold or silver; *L. de plomo*, a pig of lead. (Halse)

Lining. 1. (Derb.) Clay ironstone in beds or bands. (Gresley)
2. The plank arranged against framed sets. (C. and M. M. P.)
3. (Newc.) Same as Dialling. (Raymond)
4. A protecting coating on the boshes of puddling furnaces, or on the interior of blast furnaces. (Standard)

Lining mark (Eng.). A drill hole in the mine roof with a wooden plug driven into it from which to hang a plumb line. (G. C. Greenwell)

Lining sight. An instrument consisting essentially of a plate with a longitudinal slot in the middle, and the means of suspending it vertically. It is used in conjunction with a plumb line for directing the courses of underground drifts, headings, etc. (Webster)

Lining up a mine. In surveying, placing the sights for driving entries, drifts, or rooms nearer the working face. (Steel)

Link. One of the links of a surveyor's chain and equal to 7.92 inches. (Webster)

Linked vein. A steplike vein in which the ore follows one fissure for a short distance, then passes by a cross fissure to another nearly parallel, and so on. (S. F. Emmons)

Linnæite; Cobalt pyrite. A sulphide of cobalt, Co_3S_4. A part of the cobalt is nearly always replaced by nickel and to a less extent by iron and copper. (U. S. Geol. Surv.)

Linn and wool (Lanc.). Streaky gray sandstone. (Gresley)

Linnets (Derb.). Oxidized lead ores. (Raymond)

Linophyre. A rock in which the phenocrysts are arranged in lines or streaks. (Iddings, Igneous Rocks, p. 224)

Linseed earth (Shrop.). A dark gray clay suitable for making fire brick. (Gresley)

Linsey (Lanc.). Strong bind; also streaky sandstone (Gresley). A kind of clay rock.

Linternilla (Mex.). The drum of a horse whim. (Dwight)

Lip. 1. (Mid.). The lower part of the roof of a gate-road near the face, taken down as the face advances.
2. The edge of a front slip. (Gresley)
3. The digging edge of a dredge bucket. (Weatherbe, p. 145)

Liparite. A synonym for Rhyolite, and largely used among Europeans, though rhyolite is chiefly current in America and England. The name is derived from the Lipari Islands, off the coast of Italy, where this rock is abundant. It was proposed by Justus Roth in 1861. (Kemp)

Lipe; Lype; Leip (Scot.). A small hitch or irregularity in the joints of a coal seam. (Barrowman)

Lipey blaes (Scot.). Lumpy bind or shale. (Gresley)

Lipis (Sp.). Blue vitriol; copper sulphate. (Halse)

Lip of shaft (Eng.). The bottom edge of a shaft circle where open to the seam workings. (G. C. Greenwell)

Lip screen. A small screen or screen bars, placed at the draw hole of a coal pocket to take out the fine coal. (Steel)

Lipta (Peru and Bol.). Ash-colored or gray silver ores, accompanying tin lodes. (Dwight)

Liquation; Eliquation. 1. Separating an alloy by heating it so as to melt the more fusible of its ingredients, but not the less fusible. (Raymond)
2. As applied to the sulphur industry, a method of recovering sulphur by liquefying under pressure and heat and drawing off the molten sulphur and allowing it to solidify.

Liquation furnace. A furnace specially adapted to liquation. (Century)

Liquation hearth. A hearth specially adapted to liquation. (Century)

Liquefaction. The act or process of liquefying, or of rendering or becoming liquid; reduction to a liquid state. (Century)

Liquid fuels. The liquid fuels most frequently used are: Petroleum and refinery residues, shale oil, tar from the dry distillation of coal and wood, the tar oils obtained by the distilla-

tion of coal tar, benzine, and denatured, methylated, or wood alcohol. (Bacon)

Liroconite. A natural hydrous arsenate of aluminum and copper, occurring in bluish-green crystals. (Chester)

Lis (Mex.). The flouring of mercury. (Dwight)

Liso (Colom.). 1. A slickenside. 2. A fault. 3. A slide. 4. The flat and extensive face of a rock. (Halse)

Lissen (Eng.). A cleft in a rock. (Century)

List (Eng.). A mine inspector's term for the schedule of particulars of accidents. (Gresley)

Lista (Mex.). In the *patio* process, a tail of impure mercury. (Halse)

Listing. *See* Lashing.

List mill. In gem cutting, a wheel covered with list or cloth, on which the gems are polished. (Standard)

List pan. A perforated skimmer for skimming molten tin. (Standard)

List pot. In tin-plate manufacturing, the last of a series of five pots used in coating the plates. (Standard)

Listvenite. A local name for a rock in the gold-mining district of Beresov, in the Urals. It is regarded as a contact zone produced from dolomite, and is a coarsely crystalline aggregate of magnesite, talc, quartz, and limonite, pseudomorphic after pyrite. (Kemp)

Litchfieldite. A variety of nephelite syenite, whose chief feldspar is albite and which differs therein from normal nephelite syenite. (Kemp)

Liter; Litre. A measure of capacity in the metric system, being a cubic decimeter, equal to 61.022 cubic inches, or 0.880 imperial quart, or 0.908 U. S. dry quart, or 1.0567 U. S. liquid quarts. It is equal to one kilogram of water at maximum density. (Webster)

Litharge. Lead monoxide, PbO, made by heating lead moderately in a current of air. It is straw-yellow, and is used as a pigment, in making flint glass, and for glazing pottery. Called also Massicot (Standard). Also used in assaying.

Lithia mica. *See* Lepidolite.

Lithical. A term proposed by L. Fletcher for the finer, textural characters of rocks, *i. e.*, those for which texture, as distinguished from structure, is employed above. Lithical, from the Greek for stone, is contrasted with petrical, from the Greek for rock. (Kemp)

Lithionite. Same as Lepidolite. A lithia mica.

Lithiophilite; Triphylite. A phosphate of iron, manganese and lithium, $Li(Fe,Mn)PO_4$, varying from the bluish-gray triphylite with little manganese to the salmon-pink or clove-brown lithiophilite with but little iron. (Dana)

Lithiaphorite. A manganese mineral near psilomelane, containing some lithium. (Chester)

Lithium. A soft, silver-white metallic element of the alkali group, the lightest metal known. Symbol, Li; atomic weight, 6.94; specific gravity, 0.59. (Webster)

Lithoclase. Daubrê's term for divisional planes due to rupture. (Power)

Lithoclast. One who breaks stones. (Century)

Lithofracteur. Nitro-glycerine mixed with siliceous earth, charcoal, sodium and sometimes barium, nitrate, and sulphur. (Raymond)

Lithogensy. The science of the origin of minerals and of the causes of their modes of occurrence. (Standard)

Lithoglyph. A carving or engraving on a stone or gem; also, a stone or gem so engraved. (Standard)

Lithoglyptics. The art of gem-cutting; the cutting or engraving of precious stones or gems. (Standard)

Lithographic slate. *See* Lithographic stone.

Lithographic stone. A fine-grained homogeneous limestone suitable for etching. (U. S. Geol. Surv.)

Lithoidal. A descriptive term applied to those groundmasses, especially of rhyolites, that are excessively finely crystalline, like porcelain, as distinguished from glassy varieties. The English equivalent 'stony' is also used. (Kemp)

Lithologic. Pertaining to lithology, or the study of rocks. Pertaining to rock character. *See* Petrology. (Ransome)

Lithologist. A student of or specialist in lithology. (Standard)

Lithology; Petrology. The study of rocks as such; a branch of geology much developed in recent years. By making thin sections and examining them under the microscope the nature of a rock may be determined as well for most purposes as by chemical analysis. (Roy. Com.)

Lithomarge. A smooth, compact variety of common kaolin. (Dana)

Lithophosphor. A mineral, as barite, that becomes phosphorescent when heated. (Standard)

Lithophyl. A petrified leaf or its impression, or a stone containing such petrifaction. (Standard)

Lithophysa. In petrology a variety of spherulite consisting of concentric, roughly spherical or hemispherical shells with thin vacant spaces between them (La Forge). Literally a "stone bubble," a name applied to those cellular cavities in acidic lavas, obsidian, rhyolite, etc., that have concentric walls, and that are caused by a special development of mineralizers at that particular point.

Lithopone. A mixture of zinc sulphide and barium sulphate, prepared by precipitation, and used extensively as a pigment; also used in the manufacture of linoleum, rubber tires, etc.

Lithosphere. In geology, broadly, the solid globe of the earth, as contrasted with the enveloping hydrosphere and atmosphere. Especially the earth's crust; the outermost portion or shell of the globe, of unknown thickness, which is believed from direct observation or reasonable deduction to consist of solid rock, as distinguished from the unknown barysphere or centrosphere. (La Forge)

Litmus paper. A paper dipped into a solution of litmus, and used to test solutions in order to determine whether they are acid or alkaline. (Standard)

Little giant. A jointed iron nozzle used in hydraulic mining. *See* Giant. (Hanks)

Little Jap. *See* Rock drill.

Little tops (Aust.). A local name given to a thin band of coal occurring above the main seam. (Power)

Little winds. 1. (Corn.) A sump. 2. An underground shaft, sunk from a horizontal drift (Pryce). A winze.

Littoral. Of or pertaining to a shore. A coastal region. (Webster)

Littoral rocks. Rocks composed of coarse material deposited within the limits of the littoral zone, and so subjected to the winds and tides. (Standard)

Live. 'Charged with electricity' to such a potential as to be in a condition to give a dangerous electric shock. (H. H. Clark)

Live load. In mechanics, a load that is variable, in distinction to a constant load. (C. and M. M. P.)

Live lode. A lode containing valuable minerals.

Lively coal (Ark.). Small, and generally hard coal that may be chipped off in good-sized pieces while being undermined or sheared with a pick. (Steel)

Live quartz. A variety of quartz usually associated with a valuable mineral. (Ihlseng)

Liver opal. A synonym for Menilite (Chester). A dull-gray opaque concretionary opal.

Liver ore. A liver-brown variety of cuprite; also applied to a variety of cinnabar. (Power)

Liver pyrites. A massive form of iron sulphide (marcasite and sometimes also pyrite and pyrrhotite) having a dull liver-brown color. (Century)

Liver rock. A variety of sandstone which breaks or cuts as readily in one direction as in another. In other words, the working of the stone is not affected by stratification. (Merrill)

Liverstone. A variety of barite that gives off a fetid odor when rubbed or heated. (Century)

Live steam. Steam direct from the boiler, having its full power of expansion,—distinguished from exhaust steam, which has been deprived of its available energy. (Webster)

Living rock. Rock in its original or native state or location; rock not quarried. (Webster)

Livingstonite. A natural mercury-antimony sulphide, $H_2S.2Sb_2S_3$. Resembles stibnite in form. Color lead-gray; streak red. (Dana)

Lixiviar (Sp.). To leach; lixiviate. (Lucas)

Lixiviation. The separation of a soluble from an insoluble material by means of washing with a solvent (Raymond). Used in certain metallurgical processes. *See* Augustin, Patera, Russell, and Ziervogel processes.

Lizard. A forked piece of timber used as a stone sled; a stone-boat. (Standard)

Lizard stone. A kind of serpentine from Lizard Point, Cornwall, England. (Webster)

Lizote (Mex.). Quartz containing blue specks, and often rich in silver. (Halse)

Llamar (Mex.). To signal for the cage or bucket. (Dwight)

Llampera (Chile). A deposit containing ore in a fine or friable condition. (Halse)

Llamperos (Chile). Many small fissures filled with copper ore, traversing igneous rocks. (Halse)

Llampu. 1. (Bol.) A thin layer (*guia*) formed of isolated crystals of cassiterite in decomposed feldspar. (Halse)
2. (Peru) Fine ore passing through ½ to ¾ inch screen. (Pfordte)

Llanca (Chile). A copper silicate. (Halse)

Llano (Sp.). A plain; land more or less horizontal with but few elevations. (Halse)

Llanta (Sp.). The tire of a wheel. (Halse)

Llanura (Mex.). An extensive plain. (Dwight)

Llapa (Peru). 1. An additional quantity of mercury added. 2. A gratuity given to a buyer. (Halse)

Llapar (Peru). To add quicksilver to the pulp when the amount already added is in the condition of amalgam. (Dwight)

Llauca (Peru). 1. Taking down the vein, when softer than the wall, by using rods 7 to 10 feet long. The wall is subsequently taken down until ample working width is obtained. 2. A black clay found in veins. (Halse)

Llave (Sp.). 1. A key, or wrench. 2. Any piece of mine timber. 3. Any barren piece of ground left as a support in mines. (Halse)

Lleira (Sp.). A place full of pebbles or coarse gravel. (Halse)

Llenadores (Braz.). Bucket fillers. (Halse)

Llicteria (Peru). A Bolivian ore containing lead, tin, zinc, and silver. (Dwight)

Llimpi (Peru). Ores of red color, generally cinnabar. (Dwight)

Llinqui (Peru). Sterile strata in alluvial deposits, composed of argillaceous material of glacial origin. (Halse)

Load. 1. (Scot.) An old measure of weight for coal. (Barrowman)
2. The resistance, to a motor or engine, of the machinery that it drives, apart from its own friction. 3. Downward pressure on a structure caused by gravity alone (dead load) or by gravity increased by the stress of transverse motion (live load), as in the case of a train crossing a bridge. (Standard)

Load dropper; Car dropper (Ark.). A person who runs loaded cars down a gently inclined track, one at a time. (Steel)

Loaded track. A track used for loaded mine cars. (Steel)

Loader. The man who loads coal at the working face after the coal has been shot down. He also keeps the working place in order. (Steel)

Loader-off (Eng.). A man who regulates the sending out of the full cars from a longwall stall, or gate. (Gresley)

Loading pick (Eng.). A pick for cleaning coal. (Bainbridge)

Loadings (Eng.). Pillars of masonry carrying a winding drum or pulley. (Gresley)

Load of ore (Derb.). At mines where ore is not weighed, a measure of 9 dishes. *See* Dish, 1. (Mander)

Load-out. To load coal or rock that is to be taken out of the mine. (Steel)

Loadstone; Lodestone. A piece of magnetite possessing polarity like a magnetic needle (Webster). Also called Loadstar, Lodestar.

Load stress. The stress produced by a load. (C. M. P.)

Loam. 1. A potter's clay, containing mica or iron ocher. An impure clay. (Raymond)
2. Earthy matter composed of clay and sand, enough of the latter being present to counteract the cohering property of the clay, or of particles intermediate in size between those of clay and sand, as loess. (Webster)
3. In founding, a mixture of sand and clay, to which straw, horse dung, or other binding material is frequently added. Used to make molds for iron or brass castings. (Standard)

Loam beater. A rammer used in making a loam mold. (Standard)

Loam board. A founder's tool and templet used in making cores of loam. (Century)

Loam box. A container in which loam is boiled in water by leading a steam pipe into the mixture. The mixture is used in blast-furnace runners. (Willcox)

Loam cake. A disk of dried loam used to cover a loam mold, having holes through which melted metal is poured and air escapes. (Standard)

Loam casting. A casting made in a *loam* mold. (Standard)

Loam mold. A founder's mold made of loam, and usually requiring no pattern. (Standard)

Loam molding. The act or operation of sweeping up a mold in loam, by templates; distinguished from dry-sand molding. (Standard)

Lobbs (Eng.). Underground stairs; also, applied to a vein irregular in descent. (Bainbridge)

Lob of gold. A small but rich deposit of gold. (Skinner)

Local metamorphism. Contact metamorphism, as distinguished from regional metamorphism. (Kemp)

Locate. To mark out the boundaries of a mining claim and establish the right of possession. (Skinner)

Location. 1. The act of fixing the boundaries of a mining claim, according to law. 2. The claim itself. (Raymond)
3. The steps taken by the locator to indicate the place and extent of the surface which he desires to acquire, including the placing of a notice on the ground in some conspicuous position giving the name of the locator, with the requisite description of the extent and boundaries. (Peabody Gold Mining Co. *v.* Gold Hill Mining Co., 97 Fed. Rept., p. 661; Smelting Co. *v.* Kemp, 104 United States, p. 661; Del Monte Mining, etc., Co. *v.* Last Chance Mining, etc., Co., 171 United States, p. 74; Collins *v.* Bubb, 73 Fed. Rept., p. 739) (Also U. S. Min. Stat., p. 51)
4. A place of residence or settlement; a subdivision of a county (Webster)
5. A townsite in a mining or lumbering district.

Location survey. 1. *See* Location, 1.
2. Laying out the line of railroad or canal, or the like.

Location work. Labor required by law to be done on mining claims within 60 days of location, in order to establish ownership (Weed). Synonymous with Assessment work.

Loch; Loch holes (Derb. and Wales). Large cavities in veins in which spar is found (Power). *See* Vug.

Lock band. A course of bond stones in masonry construction. (Webster)

Locked-wire rope. A rope with a smooth cylindrical surface, the outer wires of which are drawn to such shape that each one interlocks with the other and the wires are disposed in concentric layers about a wire core instead of in strands. Particularly adapted for haulage and rope-transmission purposes. (C. M. P.)

Lockout. Refusal of an employer to furnish work to employees, used as a means of coercion. *Compare* Strike, 4. (Webster)

Lock piece (Eng.). A piece of timber for supporting the mine workings (Bainbridge). *See* Lock timber.

Lock timber. An old plan of putting in stull pieces in Cornwall and Devon. The pieces were called lock pieces. (Raymond)

Lodar; Enlodar (Sp.). To line wet blasting holes with clay. (Halse)

Lode (Corn.). Strictly a fissure in the country-rock filled with mineral; usually applied to metalliferous lodes. In general miners' usage, a lode, vein, or ledge is a tabular deposit of valuable mineral between definite boundaries. Whether it be a fissure formation or not is not always known, and does not affect the legal title under the United States Federal and local statutes and customs relative to lodes. But it must not be a placer, *i. e.*, it must consist

of quartz or other rock in place, and bearing valuable mineral. (Raymond)

As used by miners, before being defined by any authority, the term "lode" simply meant that formation by which the miner could be led or guided. It is an alteration of the verb "lead;" and whatever the miner could follow, expecting to find ore, was his lode. Some formation within which he could find ore, and out of which he could not expect to find ore, was his lode. (Eureka Cons. Min. Co. *v.* Richmond Min. Co., 4 Sawyer, p. 311; 8 Federal Cas., p. 819; Ambergris Min. Co. *v.* Day, 12 Idaho, p. 115; 85 Pacific, p. 109; Harrington *v.* Chambers, 3 Utah, p. 94; 1 Pacific, p. 362.) Lode, as used by miners, is nearly synonymous with the term vein, as employed by geologists. The word should not be used for a flat or stratified mass. *See* Ledge, 1, Lead, 1, Fissure, Fissure vein, Vein. (Additional cases are cited in U. S. Min. Stat., p. 44)

Lode claim. *See* Vein claim.

Lode country. *See* Ore channel.

Loded. Magnetized by a lodestone. (Standard)

Lode mining-claim. A mining claim including a lode, fissure, or fissure vein. In the United States the maximum length along the lode or vein is 1,500 feet and the maximum width is 600 feet.

A tract of land with defined surface boundaries, including all lodes, veins, and ledges throughout their entire depth, the top or apex of which lies inside of vertical planes extended downward through the surface boundary lines, although such veins in their downward course may extend outside of the vertical side planes of the surface location. (Paul *v.* Cragnaz, 25 Nevada, p. 327.) The extension of inclined veins beyond the side lines has resulted in much litigation. In Mexico a claim is 100 meters square, and is bounded by vertical planes through the surface lines. *See* Claim; Mining claim.

In some mining districts, as Bisbee, Arizona, the operating companies have entered into mutual contracts, specifically eliminating extralateral rights, and defining underground property rights by downward vertical planes through the surface boundaries.

Lode plot. A horizontal lode. (Skinner)

Lodestone. 1. Magnetic iron ore. *See* Loadstone. 2. Stone found in veins or lodes. (C. and M. M. P.)

Lode stoovan (Eng.). An open cutting toward a vein in rising ground. (Bainbridge)

Lodestuff. All the material contained in a vein or lode, including gangue and ore. (Standard)

Lodge. 1. (Eng.) A subterranean reservoir for the drainage of the mine made at the shaft bottom, in the interior of the workings, or at different levels in the shaft (Gresley). A sump.
2. (Scot.) A cabin, at the mine shaft, for workmen. (Barrowman)
3. (Wales) *See* Platt. 4. The room or flat at the shaft into which the pushers or trammers empty their loads. (Standard)

Lodge moraine. A kind of terminal moraine consisting of material pushed along by the glacier but falling short of its front. (Standard)

Lodgment (Scot.). *See* Sump, *also* Lodge.

Lodgment level (Scot.). A room driven from a level a short distance to the dip and used for storage of water (Barrowman). A sump.

Lodo (Sp.). Mud or slime. (Halse)

Loess. In geology, a yellowish, fine-grained, slightly calcareous, loamy clay, commonly unstratified but having some vertical jointing, believed to be a deposit of wind-blown dust (La Forge). The name is a German word, akin to "loose," and appears to have been first applied geologically in the Rhine valley. (Kemp)

Loess kindchen. A spheroidal or irregular nodule of calcium carbonate found in loess. (Standard)

Lofthead (No. Staff.). A cavity, in a mine roof, produced by a fall. (Gresley)

Lofting. 1. (So. Wales) An old or disused heading over the top of another one. 2. (No. of Eng.) *See* Lacing, 1. (Gresley)
3. (Scot.) Wood filling up vacant space on top of crowns or gears. (Barrowman)
4. Timbers, usually old, laid across the caps of steel frames or sets in a working to support the roof. (Webster)

Lofty tin (Corn.). Large and rough tin ore. (Davies)

Log. 1. (So. Staff.) A balance-weight near the end of the hoisting-rope of a shaft to prevent its running back over the pulley. (Raymond) 2. (No. Staff.) *See* Dolly, 2. 3. The record of an engine, boiler, or other trial, in which a series of observations have been taken (Webster). Also the record of a drillhole, as the log of an oil well.

Loggan stone (Eng.). A weather-worn block so finely balanced on its pivot-like base that a very ordinary force suffices to make it log, or rock from side to side. Properly Logging stone, and perhaps better known as Rocking-stone. (Page)

Logged up. Supported by trees, props, or puncheons. (Gresley)

Logging. The business of cutting and getting out logs or timber from a forest (Century). Often closely associated with mining for the purpose of obtaining mine timbers.

Logging stone. *See* Loggan stone.

Log washer. A slightly slanting trough in which revolves a thick shaft or log, carrying blades obliquely set to the axis. Ore is fed in at the lower end, water at the upper. The blades slowly convey the lumps of ore upward against the current while any adhering clay is gradually disintegrated and floated out the lower end. (Liddell)

Lohmannizing. A process by which a protective zinc coating is amalgamated to a base-metal sheet. (Liddell)

Loiseau furnace. A gas-fired furnace for the distillation of zinc ores. (Ingalls, p. 446)

Lokie (Penn.). A local term for locomotive.

Löllingite. Essentially iron diarsenide, $FeAs_2$, but passing into Fe_2As_3. Closely related to arsenopyrite or mispickel. (Dana)

Loma (Sp.). A long, comparatively narrow, somewhat flat-topped mountain ridge, or ridge of hills. (Standard)

Lombong (Malay). An open-pit mine in a valley.

Lomerio (Sp.). A series of *lomas*. (Dwight) *See* Loma.

Lomonite. Same as Laumontite. (Standard)

Lona (Mex.). Canvas. (Dwight)

London clay. A geological formation near London, England. It has a maximum thickness of about 500 feet. (Century)

London white. White lead. (Standard)

Long clay. Clay possessing a high degree of plasticity. (Century)

Longitude. 1. Distance east or west on the earth's surface, measured by the angle which the meridian through a place makes with some standard meridian as that of Greenwich or Paris. 2. In surveying, the distance between two lines drawn north and south through the extremities of a course; easting or westing. (Standard)

Longitudinal fault. *See* Fault.

Longmaid process. *See* Henderson process.

Long pay (So. Wales). A system of paying wages. (Gresley)

Long-pillar work. A system of working coal seams in three separate operations: (*a*) Large pillars are left. (*b*) A number of parallel headings are driven through the block; and (*c*) the ribs or narrow pillars are worked away in both directions. (C. and M. M. P.)

Long tom. An inclined trough in which gold-bearing earth or gravel is crudely washed. It is longer than a rocker. (Webster)

Long ton. A ton of 2,240 avoirdupois pounds. Equal to 1,016.06 kilograms. (Webster)

Longues tailles (Fr.). Same as Longwall.

Longwall. A system of working a seam of coal in which the whole seam is taken out and no pillars left, excepting the shaft pillars, and sometimes the main-road pillars. *Longwall advancing*, mining the coal outward from the shaft pillar and maintaining roadways through the worked-out portion of the mine. *Longwall retreating*, first driving haulage road and airways to the boundary of a tract of coal and then mining it in a single face without pillars back toward the shaft (Steel). Also known as Longwork, Shropshire method, Combination longwall and Nottingham or Barry system.

Longwall stope. *See* Flat-back stope.

Longwall stoping. *See* Overhand stoping.

Long weight. *See* Long ton.

Longwork. *See* Longwall.

Loob; Loobs (Corn.). The clayey or slimy portion washed out of tin ore in dressing. (Raymond)

Looking (No. Staff.). Examining the unwalled sides of a shaft. (Gresley)

Lool. A vessel to receive ore washings. (Standard)

Loop. 1. *See* Loup, 1 and D-Link. 2. A sling at the end of a hoisting rope.

Loop drag. An eye at the end of a rod through which tow is passed for cleaning boreholes. (Raymond)

Looping. The fusing of ore into a mass when the ore is only heated for calcination (Standard). *Compare* Loup, 1.

Loors (Corn.). Refuse sludge from washing tin ore. (Webster)

Loose (Eng.). 1. Applied to a working place to denote that it is open at both sides—that is, that the coal has been previously removed at both sides. "Loose at an end," or "loose at one side," denotes that the coal has been worked or mined at one side. 2. The end of a shift or of the day's work is spoken of as "Loosing time," or "Loose," or "Kenner;" and when the workmen leave, the pit is said to be "loosed out." (Redmayne)

Loose-end. 1. A gangway in longwall working, driven so that one side is solid ground while the other opens upon old workings. *See* Fast-end. (Raymond)
2. Coal prepared by cutting, or that coal which is certain to be loosened by a shot. (Steel)
3. The limit of a stall next to the goaf, or where the adjoining stall is in advance. (Gresley)

Loose needle. Same as Dial.

Loosening bar. An implement for loosening a pattern from a sand mold. (Standard)

Loose rails (Aust.). Rails that can be lifted and placed across a permanent line when desired to run skips across it. (Power)

Loosing (So. Staff.). Lowering a cage, etc., into a shaft or pit. (Gresley)

Lord (Corn.). Landlord; the owner of the soil or mineral, to whom rent or royalty is payable. (Davies)

Lordship. 1. (Scot.) A mineral property. (Barrowman)
2. (Scot.) Royalty or acreage rent. (Gresley)

Lord's mear (Eng.). The portion of ore that belongs to the owner of the land. (Hunt)

Lorry. 1. (York.) A movable bridge over a shaft top upon which the bucket is placed after it is brought up for emptying. (Gresley)
2. A car used on mine tramways, or at coke ovens. *See* Larry.
3. A long wagon having a low platform and four small wheels. (Standard)

Lorry track. In coke making, a car track laid, in block ovens, between the two parallel lines of ovens composing a block; and in bank-ovens just back of a single row of ovens composing the bank. (Century)

Losa. 1. (Sp.) A flat stone; a flagstone. 2. (Chile) A mass of rock about 20 feet thick formed of fragments of recent shells and pebbles firmly cemented together. (Halse)

Lose. 1. (Eng.) To work a seam of coal, etc., up to where it dies out or is faulted out of sight. This is called "losing the coal." 2. To be unable to work out a pillar on account of thrust, creep, gob fire, etc. 3. A pit shaft is said to be "lost" when it has run in or collapsed beyond recovery. (Gresley)

Losero. 1. (Sp.) A flagstone quarry. 2. (Mex.) At Guanajuato, sandstone quarries yielding a beautiful, colored stone for building purposes. (Halse)

Losing-iron. *See* Furnace losing-iron.

Lost level (Corn). A level or gallery driven with an unnecessarily great departure from the horizontal. (Raymond)

Lost river. In geology, a river that, by a secular increase in aridity, at first periodically in the driest season, and at last permanently, has lost its trunk, its remnental detached tributaries losing themselves in the arid ground. (Standard)

Lost-wax process. A process of executing bronze casting by casing a wax model with plaster and afterward melting out the wax. (Standard)

Lot (Eng.). The lord's (land owner) dues; a royalty. (Bainbridge)

Lough. 1. (Lanc.) An irregular cavity in an iron mine. (Gresley)
2. A lake in Ireland. (Century)

Loup. 1. The pasty mass of iron produced in a bloomery or puddling furnace. *See* Puddle-ball. (Raymond)
2. (Scot.) Slip or fault. (Barrowman)

Low. 1. (No. of Eng.) A candle or other naked light carried by a miner. Also spelled Lowe.
2. (Forest of Dean) *See* Horse, 1 and 2.
3. Not high in upward extent; having little vertical extension, as a low roof in a mine. 4. Lying below the natural or general level, as a low valley.

Low blast. A blast delivered to a smelting furnace at low pressure. (Standard)

Low coal. Coal occurring in a thin seam or bed. (Steel)

Low doors (Scot.). The lowest of two or more landings in a shaft. (Barrowman)

Lowe (Newc.). A light. A "piece of lowe" is part of a candle. (Raymond). *See also* Low, 1.

Lower leaf (Scot.). The lower portion of a seam of coal that is worked in two sections or leaves. (Barrowman)

Lowe rope (No. of Eng.). A piece of rope used as a torch. (Gresley)

Low explosives. A term sometimes used to designate explosives that do not detonate, as blasting powder, in distinction to high explosives, such as dynamite. (Du Pont)

Low-freezing dynamite. A dynamite so made that its freezing point is below that of such dynamites as contain only nitroglycerin and an active base and which have a normal freezing point of about 45° F. Low-freezing dynamites do not freeze until temperatures below 32° F. are reached, and even then only after prolonged exposure. (Du Pont)

Low-grade. 1. An arbitrary designation of dynamites of less strength than 40 per cent. It has no bearing on the quality of the materials, as they are of as great purity and high quality as the ingredients in a so-called high-grade explosive. (Du Pont)
2. A term applied to ores relatively poor in the metal for which they are mined; lean ore.

Low level; Laigh level (Scot.). The drift or working which is furthest to the dip. (Barrowman)

Low lift; Laigh lift (Scot.). The lowest set in a system of pumps. (Barrowman)

Low powders. Explosives containing a small proportion of nitroglycerin and a base similar to blasting powder. Intermediate between blasting powder and dynamite in action. (Du Pont). *See* Low-grade, 1.

Lowse (Scot.). To cease working. "The pit's lowsed," *i. e.*, work has ceased for the day (Barrowman). *Compare* Loose, 2.

Low steel. Steel low in carbon, and hence comparatively tough and soft, and usually not susceptible of hardening or tempering. (Standard)

Low-terrace drift (Aust.). Gravel and shingle in terraces. (Century)

Loxoclase. An orthoclase containing considerable sodium. (Webster)

Loza. 1. (Sp.) Pottery. 2. (Peru) Bedrock in alluvial mines. (Halse)

Lubricante (Mex.). Lubricant. (Dwight)

Lubricites. A word used by M. E. Wadsworth to include all mineral lubricants or antifriction materials. (Power)

Luce and Rozan process. A modification of the Pattinson process whereby the molten lead is stirred by the injection of steam. Used in desilverizing base bullion. (Hofman, p. 418)

Luciite. Chelius' name from the Luciberg in Hesse, for finely crystalline, diorite dikes, whose minerals are xenomorphic. (Kemp)

Luckhart furnace. A continuously working shaft furnace for roasting quicksilver ores, having the fireplace in the shaft at the bottom, protected by a cast-iron roof. The fuel is wood. (Raymond)

Luckite. A vitreous green variety of melanterite in which part of the iron is replaced by manganese, $(MnFe)SO_4 \cdot 7H_2O$, that crystallizes in the monoclinic system. (Standard)

Lucullite. A variety of marble, colored black by carbon, and obtained from Egypt. (Webster)

Lue (Prov. Eng.). To sift: a miner's term. (Standard)

Lum. 1. A chimney over an upcast shaft to increase the draft. (Raymond)
2. (Derb.) A basin or natural swamp in a coal seam, often extending several hundred yards. (Gresley)
3. (Eng.) An area of softness in a coal seam. (Webster)
4. (Scot.) A fall of roof in which the breakage of the rock extends in a conical form to a considerable height. (Barrowman)
5. (Eng.) A hole at the foot of a shaft for collecting water (Bainbridge). Also spelled Lumb. A sump.

Lumachelle. A dark brown shelly marble, having brilliant fire or *chatoyant* reflections from within. Also called Fire marble. (Ure)

Lumb (Eng.). *See* Lum, 5.

Lumberings (Derb.). Bumps over old workings. (Gresley)

Lumbrera. 1. (Sp.) An air shaft; an adit shaft. (Min. Jour.)
2. (Mex.) A porthole in a furnace. (Dwight)

Lumhead (Scot.). A chimney top. *See* Lum, 1. (Century)

Lump coal. Coal in large lumps; the largest size brought from the mine (Webster). Also, the largest marketable size.

Lunar caustic. Silver nitrate cast into sticks for use by surgeons. (Century)

Luncart; Lunker (Scot.). A lenticular mass, nodule, or ball. (Barrowman)

Lungmotor. A trade name for a mechanical device for inducing respiration in cases of asphyxia, drowning, electric shock, etc. It consists of two parallel cylinders with pistons externally connected so that a stroke in one direction exhausts the lungs through one cylinder while the other cylinder fills with air, oxygen, or both, and a stroke in the opposite direction inflates the lungs with the air or oxygen and discharges the foul gases drawn from the lungs.

Lurmann front. An arrangement of water-cooled castings through which iron and cinder are tapped from the blast furnace, thus avoiding the use of a forehearth. *See also* Closed front. (Raymond)

Lurry. 1. (York.) A weighted tram to which an endless rope is attached, fixed at the inbye end of the plane, forming part of an appliance for taking up the slack rope. 2. A movable platform on wheels, the top of which is level with the bank or surface. It is run over the mouth of a shaft to receive the bucket when it reaches the top (Gresley). A variation of Lorry, 3.

Luster. 1. The character of the light reflected by minerals; it constitutes one of the means of distinguishing them. (Roy. Com.)
There are several kinds of luster, as follows: Metallic, the luster of metals; adamantine, the luster of diamonds; vitreous, the luster of broken glass; resinous, the luster of yellow resin, as that of eleolite; pearly, like pearl; silky, like silk. These lusters have different degrees of intensity, being either splendent, shining, glistening, or glimmering. When there is a total absence of luster, the mineral is characterized as being dull. (Dana)
2. In ceramics, a glaze, varnish, or enamel applied to porcelain in a thin layer, and giving it a smooth, glistening surface. (Standard)

Lustered ware. In ceramics, glazed ware painted with metallic pigments and fired a second time in a kiln so constructed that the gases come into contact with the surface, giving a prismatic effect. (Standard)

Luster ware. Pottery decorated with metallic colors. (Standard)

Luster wash. A metallic wash used upon pottery. (Standard)

Luster mottlings. A name applied by Pumpelly to certain augitic rocks, that have a shimmering luster because the shining cleavage faces of the augite crystals are mottled by small inclusions. (Kemp)

Lute. 1. Pasty matter as clay, used to close joints of chemical or metallurgical apparatus and to coat surfaces so as to protect them from the action of flame. (Skinner)
2. In bricklaying, a scraper having a cutting edge. 3. To smooth the surface of (a drying yard) before placing new bricks upon it to dry. (Standard)

Lutecium. A metallic element separated from Ytterbium in 1907. Symbol, Lu; atomic weight, 175.0.

Lutose. Covered with clay; miry. (Webster)

Luxullianite. A tourmaline granite from Luxullian, in Cornwall, that is a product of contact metamorphism. (Kemp)

Luz (Sp.). 1. Light; *L. discubierto*, a naked light used in coal mines; *L. de arco*, an arc light; *L. incandescente*, an incandescent light. 2. A section of a shaft or wall. 3. Span of a bridge or arch. (Halse)

Luzonite. A mineral closely related to enargite, found in the Island of Luzon. (Century)

Lyddite. A high explosive, chiefly picric acid, used as a shell explosive in the British service. (Webster)

Lydian-stone. 1. A compact or close-grained, nearly black, variety of jasper. A smoothed surface of this stone is used for trying the streak of gold, the color of which affords an index to its purity (Roy. Com.). 2. Touchstone. (Webster)

Lydite. *See* Basanite.

Lye (Scot.). A siding or turnout in a mine. (Gresley)

Lying side (Derb.). The lower side of a vein (Mander). That portion next to the footwall.

Lying time (Scot.). *See* Lie time.

Lying wall. Same as Footwall.

Lyncurium. A stone used for intaglios, not now identified with certainty, but supposed to be the modern hyacinth. Pliny used the name for amber, 77 A. D. (Chester)

Lynen furnace. A zinc-distillation furnace with a common condensation chamber. (Ingalls, p. 486)

Lynx stone. An early synonym for Pliny's lyncurium. (Chester)

Lyonnaise marble. A trade name for a chocolate red and white variety of dolomitic marble used mainly for wainscoting and tiling; from Malletts Bay, Lake Champlain. *See also* Winooski marble. (Merrill)

Lype (Scot.). An irregularity in the mine roof (Gresley). A projecting rock in a mine roof that may fall at any time. Usually used in the plural, and sometimes spelled Lipe.

Lyster process. A flotation process that separates galena and zinc blende by treatment, at a low temperature, with eucalyptus oil or other frothing agent, and with agitation or aeration in a neutral or alkaline, but not acid, solution of the sulphates, chlorides, or nitrates of calcium, magnesium, sodium, potassium, or mixtures of these substances. (T. J. Hoover, p. 180)

M.

Maar. A relatively flat-floored volcanic explosion crater at a vent that is either coneless or else provided with an inconspicuous cone. (Daly, p. 144)

MacArthur and Forest cyanide process. A process for recovering gold by leaching the pulped gold ore with a solution of 0.2 to 0.8 per cent of potassium cyanide, KCN, and then with water. The gold is obtained from this solution by precipitation on zinc or aluminum, or by electrolysis. (Goesel)

Maccaluba. A mud volcano. (Standard)

Macco (Mex.). Stamping and crushing as distinguished from pulverizing. (Halse)

Macerate. To reduce to a pulp by long saturation in water, or by steeping. (Webster)

Macero (Mex.). A man in charge of stamping and crushing. (Halse)

MacFarlanite. A silver ore found in the mines of Silver Islet, Lake Superior. It contains arsenic, cobalt, nickel, etc., but is not a homogeneous mineral. (Century)

Machacado (Peru). Native silver in ore. (Dwight)

Machacadora (Sp.). A rockbreaker or crusher. (Halse)

Machacar (Sp.). To crush or break ore. (Dwight)

Machada (Sp. Am.). Hand-picking; spalling. (Lucas)

Machadero (Colom.). A shed or place where ore is spalled or cobbed. (Halse)

Machado (Sp.). A hatchet. (Halse)

Machaqueo (Sp.). Bucking or cobbing of ore. (Lucas)

Machar (Sp.). To break up the ore. (Lucas)

Machays (Ecuador and Peru). Caverns, of shallow depth, and large openings, lined with sulphur. (Halse)

Machete (Sp.). A large knife heavy enough for chopping. (Dwight)

Machihembrar (Mex.). To dovetail or join with tenon or tongue and groove. (Dwight)

Machine. 1. (Eng.) A weighbridge or weighing machine upon which wagons, trams, carts, etc., are weighed, either with or without their load of coal. (Gresley)
2. (Queensland) An ore crusher. "Crushing machine" and "battery" are used synonymously with "mill" in other parts of Australia to designate the reduction plant as a whole. (Rickard)
3. Any drill or coal-cutting device, operated by air, steam, or electricity.

Machine drill. Any mechanically driven drill. *See* Rock drill.

Machine helper. A man employed to assist in the operation of a coal-cutting machine, and whose duty it is to look after the jack and assist in moving and adjusting the machine. (Robinson *v.* Virginia-Pocahontas Coal Co., 88 S. E. Rept., p. 623)

Machineman. 1. (Eng.) One who weighs coal, etc., and keeps an account of the number of cars sent to the surface. (Gresley)
2. One who operates a machine as a drill or coal-cutting machine.

Machine wall. The face at which a coal-cutting machine works. (Gresley)

Machine whim. A winding drum operated by a steam engine.

Machinist (Aust.). The man in charge of a coal-cutter. (Power)

Macho. 1. (Sp.) A male mule. 2. (Colom.) An unproductive mineral vein. 3. (Mex.) A wall plate. 4. A dike. 5. The block on which an anvil is mounted. (Halse)

Machonga (Colom.). A hard, bronze-colored iron pyrite. (Halse)

Machorro (Sp. Am.). An unproductive lode. (Lucas)

Machote (Mex.). A stake, or permanent bench mark, fixed in an underground working, from which the length and progress thereof is measured. (Dwight)

Machucador (Mex.). A crusher. (Dwight)

Machucadura (Sp.). Spalling or crushing. (Halse)

Macigno (Italy). A term applied to a siliceous sandstone, sometimes containing calcareous grains, mica, etc. (Comstock). From the Upper Eocene of the Italian Alps.

Macizo (Sp.). 1. An unworked lode. 2. A block of ground ready for stoping. 3. A pillar. (Halse)

Mackintoshite. A massive black silicate of uranium, thorium, cerium, etc. (Dana)

Macle. 1. A twin crystal., 2. Chiastolite. (Standard)

Macled. 1. Spotted or checkered, like chiastolite. 2. Twinned, as a crystal. (Standard)

Maclureite. 1. A deep-green to black pyroxene. 2. Same as Chondrodite. (Standard)

Macquisten tube process. A metallurgical process that makes use of surface tension for separating minerals, whereby some of them float and some sink. The apparatus consists of a long tube with helical grooves, which, upon rotation, screw the pulp through the tube. The tailings are removed from the bottom of a box at the upper end of the tube and the concentrates float off. (Megraw, p. 70)

Macroaxis. The *b*-axis (long) in orthorhombic and triclinic crystals.

Macrodiagonal. The longer lateral axis in the orthorhombic and triclinic systems. (Standard)

Macrodome. In crystallography, a dome parallel to the macrodiagonal. (Standard)

Macromeritic. Of or pertaining to a granitoid structure of rocks that is discernible by the naked eye; opposed to Micromeritic. (Standard)

Macropinacoid. In crystallography, a pinacoid parallel to the vertical and macrodiagonal axes. (Standard)

Macroprism. A prism whose intercept on the macrodiagonal is greater than unity. (Standard)

Macropyramid. A pyramid whose intercept on the macrodiagonal is greater than unity. (Standard)

Macroscopic. In petrology. recognizable by the unaided eye; said of characters of rocks. Now replaced by Megascopic (La Forge). It is etymologically less correct as an antithesis of microscopic than is megascopic, for *macro* is from the Greek for broad, whereas *mega* means large.

Macrostructure. A structural feature of rocks that can be discerned by the unassisted eye, or with the help of a simple magnifier. (Standard)

Made ground. A recent deposit, as of river silt. (Duryee)

Madera (Sp.). Wood; lumber. (Halse)

Madre (Sp.). 1. Bed of a river. 2. Mother liquor. 3. (Colom.) Smooth surface-rocks. An ironstone pebble; hematite. (Halse) 4. (Peru). A horizontal crossbeam in a mill. (Lucas)

Madrepore. A branching coral; also, any perforated stone coral. (Standard)

Madrepore marble. A fossiliferous limestone of Devonian age and of a variety of colors. It admits of a high polish and is used as a marble. Takes its name from the most characteristic fossil, a species of madrepore. (Merrill)

Madrier (Fr.). A flat, wooden beam used in a mine (military) to support earth. (Standard)

Madrina (So. Am.). The leader of a train of pack mules; usually a mare. (Standard)

Madupite. A vitrophyric igneous rock containing diopside, phlogopite, and perovskite in a leucitic glassy base (La Forge). The name was given by Whitman Cross to a peculiar group of rocks that are illustrated by one forming Pilot Knob, a mesa about 6 miles northeast of Rock Springs, Wyo. Cross defines Madupite "as consisting essentially of diopside and a magnesia-potash mica with leucite in decidedly subordinate amount. Its magma is low in silica, alumina, and iron, rich in potash, and contains so much lime and magnesia that silicates of these bases are the principal constituents, yet controlled in their development by the strong potash element." The Pilot Knob case is a vitrophyric representative of the type so defined. (Kemp)

Mad water (Corn.). Water that, through neglect, rushes back to the mine. (Davies)

Maenite. A name derived from Lake Maena, near Gran, Norway, and given by W. C. Brögger to an intrusive trachytic rock, regarded as a differentiation product of a gabbro-magma. Maenite is a bostonite relatively rich in lime and poor in potash. (Kemp)

Maestro (Sp.). 1. Master, master workman; *M. del bocarte*, a mill man; *M. de obras*, a contractor or builder; *M. fundidor*, a practical smelter. *M. herrero*, a master blacksmith; *M. mecánico*, a master mechanic; *M. palero*, head timberman. 2. (Peru) The principal trough in *patio* amalgamation, in which all the amalgam is gathered. (Dwight)

Mafic. In petrology, pertaining to or composed dominantly of the ferromagnesian rock-forming silicates; said of some igneous rocks and their constituent minerals. Contrasted with Felsic. (La Forge)

Maggie (Scot.). An inferior and sandy part of ironstone; inferior or stony coal. (Barrowman)

Maggie blaes (Scot.). An inferior sulphurous ironstone. (Barrowman)

Magistral (Sp.). A powder of roasted copper pyrites, used in the amalgamation of silver ores in the Mexican patio process. (Raymond)

Magistraleros (Mex.). Men who burn (roast) copper ore for *magistral*. (Halse)

Magma. In petrology, liquid molten rock; the molten material from which igneous rocks are formed by solidification (La Forge). An original, parent magma may break up into several derived ones. The word is also used in the sense of *basis* as earlier defined, but this use is unfortunate. (Kemp)

Magma-basalt. A synonym for Limburgite, proposed by Boricky in 1872, at about the same time that Rosenbusch suggested limburgite. Some authorities give the former the preference. (Kemp)

Magmatic. In petrology, of, pertaining to, or derived from magma. (La Forge)

Magmatic differentiation. In petrology, the process by which different types of igneous rocks are derived from a single parent magma, or by which different parts of a single molten mass assume different compositions and textures as it solidifies (La Forge). Also called Magmatic segregation.

Magmatic water. Water derived from cooling igneous magma. *See also* Juveline water. (Emmons)

Magnesia. Magnesium oxide, MgO. A light, earthy, white substance, obtained by heating the hydroxide or carbonate, or by burning magnesium. (Webster)

Magnesia alba. A light, white, hydrous magnesium carbonate prepared by pulverizing the mineral magnesite, or by chemical means. (Standard)

Magnesian limestone. *See* Dolomite.

Magnesite. Magnesium carbonate, $MgCO_3$. Crystals rare, usually rhombohedral, also prismatic. Commonly massive; granular, cleavable to very compact; earthy. Color white, yellowish, or grayish-white, brown. Transparent to opaque. (Standard)

Magnesium. A silver-white metallic element, malleable, ductile and light. Symbol, Mg; atomic weight, 24.32; specific gravity, 1.74 (Webster). Used chiefly in the form of ribbon or powder to produce a brilliant light by its combustion, as in signaling, photography, or pyrotechny. (Standard)

Magnes stone. A magnet. (Century)

Magnet. 1. A loadstone; a variety of magnetite or magnetic iron ore having naturally the property of attracting iron (Webster). Also called Natural magnet.
2. A large horseshoe magnet employed to lock and unlock safety lamps. The operation can be accomplished only by direct contact with the magnet.

Magnetic. Of, or pertaining to, the magnet; possessing the properties of the magnet, as a magnetic needle. (Webster)

Magnetic field. 1. The space through which the force or influence of a magnet is exerted. 2. The space about a conductor carrying an electric current in which, as it may be shown, magnetic force is also exerted. (Century)

Magnetic force. The force, attractive or repulsive, exerted between two magnetic poles; the force which produces or changes magnetization. (Webster)

Magnetic guard. A double mask of magnetized steel-wire gauze, to protect a workman from the flying dust of iron and steel. (Standard)

Magnetic iron ore. Synonym for Magnetite.

Magnetic meridian. In general, any isogonic line. Specifically, the direction assumed by the compass needle at any place; a magnetic north-and-south line.

Magnetic ore. A black, hard ore that is magnetic, as magnetite. (Standard)

Magnetic pole. Either of those points on the earth's surface where the lines of magnetic force are vertical; an end of the axis of the earth's magnetic polarity, not coinciding with a geographical pole, and changing its position slowly. The north magnetic pole is in northern British America at about lat. 70½° N., long. 97° W. (Standard)

Magnetic pyrite. Same as Pyrrhotite. (Standard)

Magnetic scale. A diagram of metals showing their comparative magnetic qualities. (Standard)

Magnetic separator. A device in which a powerful magnet separates magnetic iron ore from sand or gangue. (Standard)

Magnetism. That peculiar property possessed by certain bodies (as iron and steel) whereby, under certain circumstances, they naturally attract or repel one another according to determinate laws. (Century)

Magnetite; Magnetic iron ore. The magnetic iron oxide, $FeO.Fe_2O_3$. Contains 72.4 per cent iron (U. S. Geol. Surv.). The name of the mineral is prefixed to the names of many rocks in which it is prominent. It almost furnishes a rock itself, in places. (Kemp)

Magnetite-olivinite. A name coined by A. Sjogren in 1876 for the igneous iron ore at Taberg, in Sweden. The rock is an aggregate of magnetite and olivine, with a few shreds of biotite. The rock is practically a peridotite, greatly enriched with titaniferous magnetite. On the borders of the intrusion it shades into gabbro. *Compare* Cumberlandite. (Kemp)

Magnetite-spinellite. An eruptive iron ore occurring at Routivara, Sweden, and consisting of magnetite (in part titaniferous), spinel, and smaller amounts of olivine, pyroxene, apatite, and pyrrhotite. The ore contains about 14 per cent titanic oxide. (Kemp)

Magnochromite. A variety of the mineral chromite that contains magnesium. (Standard)

Magnophyric. Coarsely porphyritic. Containing phenocrysts that are greater than 5 mm. in longest diameter. *See* Mediophyric and Minophyric. (Iddings, Igneous Rocks, p. 200)

Maiden field (Scot.). An unbroken or unworked mineral property. (Barrowman)

Maidens (Scot.). Iron frames or standards carrying pillow blocks of shaft pulleys (Barrowman). *See* Mingles.

Main-and-tail-rope haulage. A system of haulage whereby a set of skips connect two ropes, one known as the main, the other as the tail rope. The main rope hauls the full skip out, while the tail rope draws the empties into the mine. (Power)

Main bord-gate (York.). The heading which is driven slightly to the rise from the shaft. (Gresley)

Main bottom. Hard rock below alluvial deposits. (Duryee)

Main engine (No. of Eng.). The surface pumping engine, usually of the Cornish type. (Gresley)

Main entry. 1. An entry driven at right angles with the face slips of the coal (Roy). *See also* Entry. 2. A main haulage road. *See also* main road.

Main rake (Derb.). The main or principal vein. (Mander)

Main road. The principal underground road in a district along which the coal or ore is conveyed to the shafts, generally forming the main intake air course of each district. (Gresley)

Main rod (Corn.). *See* Pump rod.

Main rope. In tail-rope haulage, the rope that draws the loaded cars out of the mine. (Steel)

Main-rope system. A system of underground haulage in which the weight of the empty cars is sufficient to draw the rope inbye. (Gresley)

Main suit (Brist.). A heavy spring or feeder of water. (Gresley)

Maintainer (Eng.). A shareholder. (Bainbridge)

Maintenage (Fr.). The face of workings in inclined or vertical seams, consisting of a series of steps each about 6 feet high, and forming the working place for one man. (Gresley)

Mainway. A gangway or principal passage. (Raymond)

Maja; Majadero (Sp.). A pestle. (Halse)

Majano (Sp.). A small heap of stones used as a landmark. (Halse)

Majar (Sp.). To pound or beat in a mortar. (Halse)

Majolica; Maiolica. A variety of earthenware coated with an opaque white enamel and decorated in colors. (Standard)

Make. 1. A formation or accumulation of profitable vein material; as, a make (*i. e.*, a body) of ore in a vein or in a series of lenticular deposits (Webster). Also called: Make of stone; Make of quartz; Make of reef.
2. The amount produced; yield; as, the make from a furnace. (Standard)

Make gas (Mid.). To yield or produce gas. A seam of coal that gives off fire damp is said to make gas. (Gresley)

Make of quartz. *See* Make, 1.

Make of reef. *See* Make, 1.

Make of stone (Aust.). A shoot of ore (Power). *See* Make, 1.

Makings (Newc.). The small coal hewn out in undercutting or channeling (Raymond). Also, in some localities, called Bug dust.

Mala (Peru). A gorge. (Halse)

Malacacheta (Braz.). A yellowish brown micaceous earth in which topaz is found. (Halse)

Malacate (Mex.). Windlass; horsewhim. Any mining hoist; *M. de arana*, an ordinary capstan. (Dwight)

Malacatero (Sp.). A whim driver. (Halse)

Malachite. Green basic copper carbonate, $2CuO.CO_2.H_2O$. Contains 40.3 per cent copper. (U. S. Geol. Surv.)

Malachite green. 1. Malachite ground and used as a pigment. 2. A green, basic dyestuff of bluish tinge, prepared by condensation of benzaldehyde with two molecules of dimethylaniline, with subsequent oxidation. (Webster)

Malacolite. A pale-colored, translucent variety of diopside. (Dana)

Malacon. A brown, vitreous variety of zircon. (Standard)

Malaquita (Sp.). 1. Malachite. 2. *M. azul*, azurite. (Halse)

Malaspina glacier. *See* Piedmont glacier.

Malchite. A variety of diorite dike that has, in a groundmass of quartz, feldspar, and hornblende, phenocrysts of plagioclase, hornblende, and biotite. The name was given by A. Osann, and is derived from Malchen, another name for Mt. Melibocus, in Hesse. (Kemp)

Maldonite. A metallic, pinkish, silver-white alloy of gold and bismuth (Au_2Bi) that is found native. (Standard)

Malecón (Sp.). 1. A dike or embankment. 2. An ore wharf. 3. A cofferdam. (Halse)

Malétra furnace. A hand reverberatory furnace for roasting finely divided ore entirely without the aid of extraneous heat. (Peters, p. 172)

Malignite. A name proposed by Lawson for a group of rocks on the Maligne River, Rainy Lake district, Province of Ontario. They are described as "basic, holocrystalline, plutonic rocks, rich in alkalies and lime." Iron is present in moderate amounts, almost entirely combined in the silicates. Iron and magnesia are more abundant than is usual in the alkali-rich plutonic rocks. The chief minerals are orthoclase, often microscopically intergrown with an acid plagioclase; aegirite-augite, which may predominate with but a moderate admixture of biotite, or may be subordinate and intergrown with preponderant soda amphibole, biotite being present as before. There are two types of malignites, one of which has much melanite and another much nephalite. (Kemp)

Malinger. 1. To feign illness; sham sickness in order to avoid duty; counterfeit disease. (Century)

Malingerer. 1. A soldier or a sailor who feigns himself sick, or who induces or protracts an illness, in order to avoid doing his duty; hence, in general, one who shirks his duty by pretending illness or inability. (Webster)

2. In industrial-accident insurance, one who feigns disability or prolongs his period of disability, in order to collect accident insurance or compensation.

Malingering. A practice indulged in by an employee, injured by accident, in order that he may collect accident insurance or other compensation, and at the same time avoid work.

Malinowskite. A variety of tetrahedrite that contains lead. (Standard)

Malla (Sp.). Mesh of a screen. (Dwight)

Malleable. Capable of being extended or shaped by beating with a hammer, as gold, silver, etc. *Compare* Brittle, Flexible, and Sectile. (Webster)

Malleable castings. Small iron castings made malleable by annealing, or decarburizing by cementation in powdered hematite or other oxide of iron. (Raymond)

Malleable iron. Cast-iron made from pig-iron of the proper kind, so treated as to render it capable of being bent or hammered to a limited extent without breaking, that is, it is malleable. Its strength is above that of cast-iron. The treatment is known as annealing. (Nat. Tube Co.)

Malleate. To shape into a plate or leaf by beating, or hammering; said of metal. (Standard)

Mallet (Corn.). The sledge hammer used for striking a drill. (Raymond)

Mallon; Mallion (Eng.). A soft kevil (Bainbridge). *See* Kevil, 1.

Malm. 1. (Eng.) A soft, grayish-white, friable limestone. 2. A rich clayey soil containing chalk; marl; also in brickmaking an artificial mixture of clay and chalk. (Webster)

Malming. The preparation of an artificial malm by mixing chalk and clay reduced to a pulp, and allowing the mixture to consolidate by evaporation. (Century)

Malm rock (Eng.). A local name for the sandstone of Surrey and Sussex; called also firestone. (Ure)

Malmstone. Same as Malm rock.

Malpais (Mex.). Ground covered with a lava flow (Halse). Literally, bad land.

Maltha. The pitch or gum resulting from the drying up and oxidation of petroleum, as when it has reached the surface of the ground. (Roy. Com.)

Malthacite. A variety of fuller's earth. (Chester)

Malting coal (Wales). Anthracite coal. (Webster)

Mama (Sp. Am.). Stake or pile driver. (Lucas)

Mammillary; Mammilated. In mineralogy, forming smoothly rounded masses resembling breasts or portions of spheres; said of the shape of some mineral aggregates, as malachite or limonite; similar to but on a larger scale than botryoidal. (La Forge)

Mamona (Braz.). Castor oil used in a miner's lamp. (Bensussan)

Mampostería (Sp.). 1. Masonry work in general. 2. Rubble work or rough-stone work. (Halse)

Mampostero (Sp.). A stone mason. (Halse)

Mampuesto. 1. (Sp.) Ashlar, rubble, rough stone, or material used in walling. 2. (Colom.) A trestle aqueduct for flumes. (Halse)

Manager. An official who has control and supervision of a mine, both under and above ground, and generally also of the sale of the product (Steel). At some mines he is called superintendent, general superintendent, or agent.

Manantial (Sp.). A spring of water; *M. caliente*, a hot spring. (Halse)

Man cage. A special cage for raising and lowering men in a mine shaft. *See also* Man car.

Man car. A kind of car for transporting miners up and down the steeply inclined shafts of some mines as at Lake Superior (Century). *See also* Man cage.

Manchado (Sp.). Spotted ore. (Halse)

Mandadero (Mex.). Errand boy; a daily messenger. (Halse)

Mandarin porcelain. A Chinese porcelain brilliantly decorated with figures of mandarins in their official robes. (Standard)

Mandelstone. Same as Amygdaloid.

Mandón (Mex.). An overseer or boss. (Dwight)

Man door (Scot.). A small trapdoor on a traveling road. (Barrowman)

Mandrel; Mandril (Eng.). A miner's pick (Webster). *See also* Maundril.

Mandrel socket. A well tool for straightening out the top of casing, etc., within a well, consisting of a lemon-shaped swage within a cone or bellmouth, by means of which the casing is worked to a circular shape. Also useful for straightening a lost sand pump, etc., so that the dogs may enter. (Nat. Tube Co.)

Manebach twin. A monoclinic twin crystal having the basal pinacoid as the twinning plane. (Dana)

Man engine. *See* Man machine.

Manero (Mex.). A single-hand hammer used by miners. (Dwight)

Manga. 1. (Mex.) Conical canvas bag to drain quicksilver out of amalgam. 2. Hose. 3. Tuyère sack. (Dwight)
4. (Sp.) An inclined chute. An ore pass. 5. (Colom.) A pasture or meadowland. (Halse)

Manganapatite. A variety of apatite in which manganese replaces calcium. (Standard)

Manganblende. *See* Alabandite.

Manganbrucite. A yellow, massive variety of brucite containing manganese. (Standard)

Manganese. A hard, brittle metallic element having a grayish-white color tinged with red and rusting like iron. Not magnetic. Symbol, Mn; atomic weight, 54.93; specific gravity, 8.0 (Webster). The black oxid, pyrolusite, the gray oxide, manganite, and the earthy oxide, wad, are used in the arts. Manganese is used extensively in hardening steel. *See* Ferromanganese; *also* Manganese steel.

Manganese bronze. Properly, bronze containing manganese, a common proportion being copper 88, tin 10, manganese 2; also, any of certain other copper-manganese alloys not, necessarily containing tin. In general, it is a reddish-white metal, remarkable for its strength and toughness. (Webster)

Manganese copper. See Manganese bronze.

Manganese glaze. A dark-colored glaze which receives its color from an oxide of manganese. (Standard)

Manganese hydrate. *See* Psilomelane.

Manganese spar. *See* Rhodonite.

Manganese steel. Steel containing about twelve per cent of manganese. A non-fissile alloy that exceeds all other known materials in its combination of hardness and ductility: used chiefly where resistance to abrasion is required, as in crushing and dredging machinery, and in some car wheels. (Standard)

Manganeso (Sp.). Manganese, manganese ore; *M. negro*, pyrolusite; *M. gris*, manganite. (Halse)

Manganin. An alloy in which manganese and nickel are compounded in somewhat small proportions with copper, the ratio of manganese to nickel being as 3 or 4 to 1. This alloy is used almost exclusively in the construction of a standard of electrical resistance, the temperature coefficient being practically zero. (Standard)

Manganite; Gray manganese ore. A hydrated manganese oxide, $Mn_2O_3 \cdot H_2O$. (U. S. Geol. Surv.)

Manganocalcite. A variety of calcite that contains manganese carbonate and is closely related to rhodochrosite. (Standard)

Manganolite. Wadsworth's name for rocks composed of manganese minerals, such as wad, psilomelane, etc. (Kemp)

Manganosiderite. A carbonate of manganese and iron intermediate between rhodochrosite and siderite. (Century)

Manganosite. Manganese protoxide, MnO. In isometric octahedrons. Cleavage cubic. Color emerald-green, becoming black on exposure. (Dana)

Mangar (Colom.). To scrape the ground sluice with a hoe in order to collect the gold. (Halse)

Mango (Mex.). A handle for pick or hammer. (Dwight)

Manguera (Sp.). Hose. (Dwight)

Manguito (Sp.). A small sleeve; a clutch; a shaft coupling. (Halse)

Manheim gold. A brass alloy resembling gold. (Century)

Manhes process. A purifying and oxidizing process for removing sulphur from copper matte, by subjecting the molten matte to a blast of air; named from the inventor (Standard). *Compare* Bessemer process.

Manhole. 1. A refuge hole constructed in the side of a gangway, tunnel or slope. 2. A small and generally very short passage used only for the ingress and egress of the miners. 3. A hole in cylindrical boilers through which a man can get into the boiler to examine and repair it. (Steel) 4. A small passage connecting a level with a stope, or with the level next above. (Webster)

Man hudge (Gloac.). A kind of barrel or box in which men ride in a shaft. (Gresley)

Mani (Colom.). 1. Large fragments of amphibolite, syenite or granite in alluvial mines. 2. In lode mines, a granitic country rock. Sometimes applied to porphyry. (Halse)

Manifesto (Sp.). A freight list; a mainfest. (Halse)

Manipulator. A machine for moving and turning over hot billets or blooms of iron or steel in the process of rolling. (Standard)

Manizal (Sp. Am.). A place abounding in *mani*. (Lucas)

Manjak. A natural bitumen found in the Barbados. The term is sometimes used to include gilsonite and its congeners and ozocerite (Mitzakis). Used in the manufacture of varnish. Spelled also Manjack.

Man machine; Man engine (Corn. and Derb.). A mechanical lift for lowering and raising miners in a shaft by means of a reciprocating vertical rod of heavy timber with platforms at intervals, or of two such rods, moving in opposite directions. In the former case, stationary platforms are placed in the shaft, so that the miner in descending, for instance, can step from the moving platform at the end of the down-stroke, and step back upon the next platform below at the beginning of the next down-stroke. When two rods are employed, the miner steps from the platform on one rod to that on the other. (Raymond)

Mano (Mex.). 1. The grinding stone of an arrastre, etc. 2. A pestle. 3. *M. de hierro*, the muller of an amalgamating pan. 4. A stamp head. (Halse)

Man-of-war (Staff.). A small pillar of coal left in a critical spot; also, a principal support in thick coal workings. (Raymond)

Manometer. An instrument for measuring the elastic pressure of gases; an accurate pressure gage. (Standard)

Manoscope. A manometer. (Century)

Man rope. A winding rope used exclusively for lowering and raising men and animals, when tacklers and swinging bonts were used and cages were unknown. (Gresley)

Manta (Sp.). 1. A woolen blanket. 2. A blanket or horse cloth used for hoisting ore by the *malacate*. 3. A bedded vein or deposit. 4. (Nicaragua) A surface deposit of broken quartz worked for gold. (Halse)

Mantear (Mex.). To hoist ore in bags or *mantas*. (Halse)

Manteo (Mex.). 1. Hoisting. 2. An inclined hoist. (Dwight)

Mantero (Mex.). Man who loads material to be hoisted in a shaft. (Dwight)

Mantle. 1. The outer wall and casing of an iron blast furnace, above the hearth. (Raymond)
2. A penstock for a water wheel.

Manto (Sp.). In mining, a layer or stratum, especially a stratum that contains gold in profitable quantity. (Standard)

Manus tester. An instrument for determining the flash point of petroleum. (Mitzakis)

Manway. 1. A small passage used as a traveling way for the miner, and also often used as an airway or chute, or both. (Steel)
2. A short heading between two chutes (Gresley). A manhole.

Map. A horizontal projection, of surface plants, mine workings or both drawn to a definte scale, upon which is shown all the important features of the mine; a plan; a plat.

Maquila (Mex.). Smelting or treatment charge; *M. y flete*, freight and treatment charge. (Dwight)

Maquilar (Mex.). To work ore for its owner on shares, or for money. (Dwight)

Maquilero. 1. (Peru) Ore buyer. (Dwight)
2. (Mex.) One who dresses ore on hire. (Halse)

Maquilla (Sp.). A mill where ore is ground on shares. (Raymond)

Máquina (Sp.). A machine or engine. *M. de barrenar*, a rock drill (Lucas). *M. de vapor*, a steam engine (Min. Jour.). *M. de extracción*, a hoisting engine; *M. exploradora*, diamond-drill machine. (Halse)

Maquipuros (Peru). A class of workmen who make only temporary visits into the mines when they are attracted by bonanzas. Most of them come from distant Provinces and return to their homes when the bonanza is exhausted (Halse). A stampeder.

Marathon mill. A form of tube mill used in the cement industry, in which the pulverizing is done by long pieces of hardened steel shafting. (Liddell)

Maray (Arg.). A kind of hand arrastre used by the Indians for reducing quartz. (Lucas)

Marble. In lithology, a metamorphosed and recrystallized limestone. In the trade, the name is applied to any limestone that will take a polish. (Kemp)

The following are some of the principal marbles: Bardiglio, bird's eye, black and gold, boagard, breccia, brocatelle, calico, campan, cannes, carrara, cipolino, eolian, fior di persicor, fire, forest, formosa, giallo antico, griotte, landscape, languedoc, lepanto, lumachelle, lyonnaise, madrepore, mischio, nero antico de prato, numidian, onyx, paonazza, parian, parmazo, pavonazetta, pentellic, petit granite, phrygian, porter, ricolite, rosso antico, rosso levanto, rouge antique, ruin, saccharoidal, St. Anne, St. Baume, sarrancolin, serpentine, sienna, stalactitic and stalagmitic, statuary, verdantique, and winooski. (Ries)

Marble band (Scot.). Musselband ironstone. (Barrowman)

Marble glaze. A glaze coating on pottery, having colored veins in imitation of marble. (Standard)

Marble handsaw. A toothless blade fitted at the back with a block handle, used with sand for cutting slabs of marble into pieces. (Century)

Marble polisher. 1. A block of sandstone used to rub a marble slab in the preliminary polishing. Also a linen cushion with which the polishing is completed by the agency of emery dust, etc. 2. A machine for polishing marble. 3. A marble rubber. (Century)

Marbler. A quarrier or cutter of marble. (Century)

Marble rubber. A rubber for surfacing, smoothing, and polishing marble slabs. (Century)

Marble saw. A machine for cutting marble. (Century)

Marca (Sp.). 1. A mark. The royal arms, stamped on a piece of assayed silver as a token of its having paid the duties to the crown. (Rockwell) 2. A surveyor's mark. 3. A Province or district. (Halse)

Marcasita (Sp.) Marcasite. (Dwight)

Marcasite. The orthorhombic iron pyrite, FeS_2. It has a slightly lower specific gravity than pyrite and somewhat paler in color. Often called White iron pyrites; Coxcomb pyrites, and Spear pyrites. (Century)

March (Scot.). The boundary of the coal or colliery. (Gresley)

Marching (Scot.). A boundary working. (Gresley)

March place (Scot.). A heading driven up to or alongside the march, or boundary of a mining property. (Gresley)

March stones (Scot.). Stones set at intervals on the surface to indicate the boundary line. (Barrowman)

Marco (Mex.). 1. Set of shaft timbers; square set. Timber frame of any kind. 2. A weight of 8.1184 oz. avoir., or 7.3995 oz. troy. 3. (Chile) A pulley frame. (Halse)

Marcus. A patented shaker screen with a non-harmonic or quick-return motion. (C. and M. M. P.)

Marcy mill. A ball mill in which a vertical diaphragm is placed about 1 foot from the discharge end. Between this perforated diaphragm and the end of the tube there are arranged screens for sizing the material, oversize being returned for further grinding while undersize is discharged. (Liddell)

Marekanite. A rhyolitic perlite from the banks of the Marekaka river, near Okhotsk, Siberia. At times a clear glass; it is found in balls and cores of large perlitic masses and may even be under strain like Prince Rupert's drops. (Kemp)

Marga. 1. (Sp.) Marl. 2. (Colom.) Spathic iron; siderite. (Halse)

Margarite. 1. A primary form of crystallization in which globulites are arranged lineally. (Webster) 2. A monoclinic mineral, $H_2CaAl_4Si_2O_{12}$. Luster of base is pearly, and that of the lateral faces is vitreous. Color grayish, reddish-white, pink, yellowish. Translucent to subtranslucent. (Dana)

Margarodite. A variety of Muscovite, or common potash mica, affording upon ignition, a small percentage of water. (Century)

Margaryine. The impregnation of timber with a solution of copper sulphate. (Century)

Margin draft. In masonry, the plain-dressed portion of the face of a hewn block next its edge. (Standard)

Maria glass. An early name for both mica and selenite. (Chester)

Marialite. A variety of scapolite. (Century)

Marignac's salt. Potassium stannosulphate, $K_2Sn(SO_4)_2$. (Liddell)

Marine metal. A sheathing material for ships, usually an alloy principally of copper. (Standard)

Mariposa (Sp.). A naked light. (Lucas)

Mariposite. A light-green variety of muscovite that is found with pyrite. (Standard)

Mariupolite. A name derived from Mariupol, a locality on the sea of Azov, and applied by J. Morozewicz to a variety of nephelite-syenite, so rich in soda and poor in potash that orthoclase practically fails. An estimate of the percentage of the component minerals gave, albite, 73; nephelite, 14; aegirite, 7.6; lepidomelane, 4; zircon, 1.6. The texture varies from coarsely crystalline to porphyritic and to compact, according to the occurrence of the rock in large masses or in dikes. (Kemp)

Mark. 1. A band of hemp, etc., wrapped around a winding rope to indicate to the engineer the position of the cage in the shaft. (Gresley) 2. The chalk mark made at the working faces, etc., by a fireboss as an indication that he has made an examination of that place.

Market house (Eng.). A point near the mine entrance to which loaded mine cars are taken for examination when it is suspected that the miner has loaded more than the allowable amount of rock with the coal.

Market lead. Lead ready for market. (Standard)

Market pot. In silver refining, the pot at the end of the series of pots used in the Pattinson process, in the direction in which the amount of silver left in the lead is diminishing. It contains the market lead. (Century)

Markings (of mining claims). These may consist of stakes, posts, piles of stone, bowlders, posting a notice on the ground, placing a notice in a tin can attached to a stake, fastening a notice to a tree, or placing it in a box or frame, blazing trees along the boundaries or at the corners, cutting away undergrowth, making a trail through the timber along the sides or ends of the claim, or blazing stumps. (Meydenbauer v. Stevens, 78 Fed. Rept., p. 791)

Marl. A calcareous clay, or intimate mixture of clay and particles of calcite or dolomite, usually fragments of shells. Marl in America is chiefly applied to incoherent sands, but abroad compact, impure limestones are also called marls. (Kemp)

Marlaceous. Resembling, having the nature of, or containing marl. (Standard)

Marl brick. A fine quality of brick used in the fronts of houses; a cutter. (Standard)

Marlinespike. A sharp pointed and gradually tapered round iron, used in splicing ropes. (C. and M. M. P.)

Marlite. Marl that has become somewhat stony in character. (White)

Marl pit. A pit where marl is dug. (Webster)

Marl slate. Calcareous shale; a variety of marl splitting into thin plates. (Century)

Marlstone. A ferruginous limestone belonging to the middle Lias of England. (Webster)

Marly. Resembling marl; abounding with marl. (Webster)

Marmaja (Mex.). 1. Iron pyrite. 2. In the *patio* process a pyritic residue obtained in separating the silver amalgam by washing. 3. (Colom.). Marcasite and pyrite frequently rich in gold and silver (Halse). *Marmajas* (Mex.). Concentrated sulphides. (Dwight)

Marmarosis. The general name for the process of crystallization of limestones to marble, whether by contact or regional metamorphism. It was coined by Geikie from the Latin for marble. (Kemp)

Marmatite. A ferriferous variety of sphalerite, containing 10 per cent or more of iron. It is dark brown to black. (Dana)

Mármol (Sp.). Marble. (Dwight)

Marmolite. A thin laminated serpentine, usually pale green. (Webster)

Marmoratum. A cement formed of pounded marble and lime mortar well beaten together. Used by the ancient Romans in building terrace walls, etc. (Century)

Marmoric. Of or pertaining to marble. (Webster)

Maroma (Sp.). A rope to pull or draw by, as a hawser. (Min. Jour.)

Marquesitas (Sp.). Mundic; iron pyrite. (Min. Jour.)

Marqueta. 1. (Mex.) A bar of lead bullion. 2. (Peru) Retort silver. 3. A brick of amalgam. (Halse)

Marriner process. A modification of the cyanide process in which the ore is dead-roasted, all of it ground to slime, and the resulting product treated by agitation. (Liddell)

Marro (Mex.). A sledge hammer. (Dwight)

Marrow (No. of Eng.). A mate, butty, or partner. (Gresley)

Marsaut lamp. A type of safety lamp characterized by multiple-gauze chimneys. (C. and M. M. P.)

Mars brown. A yellowish-brown pigment the color of which is due to iron oxide. (Webster)

Marsh. A tract of soft wet land, commonly partly or wholly covered with water; a fen; swamp; morass. (Webster)

Marsh gas. Methane. In the miner's language, synonymous with fire damp.

Marsh ore. A synonym for Bog iron ore. (Chester)

Marsh test. A delicate test for arsenic. (Webster)

Martar el circo (Peru). To add the last mercury in the patio process. (Halse)

Marsut. *See* Mazout.

Martensite. A hard brittle substance, of the nature of a solid solution, consisting of iron with 2 per cent or less of carbon, and forming the chief constituent of quenched steel. The variety that corresponds in composition to pearlite (containing 0.9 per cent carbon) is called Hardenite. (Webster)

Martillo (Sp.). A hammer or sledge used in mining or quarrying. (Halse)

Martin. A stone-faced, perforated plate or runner, used for grinding and polishing stone. (Standard)

Martin process. Called also the Siemens-Martin and the open-hearth process. Used in the manufacture of steel. (Raymond)

Martite. Ferric oxide, Fe_2O_3, occurring in iron-black crystals of isometric form, and probably a pseudomorph after magnetite. (Webster)

Marver. A polished slab or table, originally marble, but now usually iron, with rounded concavities, upon which a balloon of molten glass gathered on the end of a blowpipe is rolled to make it cylindrical or spheroidal. (Standard)

Masa (Sp.). 1. Mortar. 2. A mass of gold, silver, or other metal. 3. An irregular deposit. (Halse)
4. *M. derecha*, vertical ore deposit; *M. echada*, horizontal ore deposit. (Dwight)
5. (Peru) Pulp discharged from a Chilean mill. (Pfordte)

Mascagnite. A native ammonium sulphate, $(NH_4)_2SO_4$, that occurs about volcanoes (Dana). Also called Mascagnine.

Mash (Scot.). A double-hand hammer for breaking coal, setting up props, etc. (Barrowman)

Mason. A mechanic whose occupation is the laying of brick and stone in building; one who has charge of or contracts for mason work; also, sometimes, one who works or dresses stone for building; a stonecutter. (Standard)

Masonry. 1. The art or work of constructing, as buildings, walls, etc., with regularly arranged stones or bricks; the occupation or skill of a mason. 2. That which is built by masons; stonework; brickwork.

Mason's hammer. A square-faced hammer with a peen in line with handle. (Standard)

Masonwork. *See* Masonry, 2.

Mass action. Chemical action as affected by the masses of the reacting substances. (Webster)

Mass copper (Lake Sup.). Native copper, occurring in large masses. (Raymond)

Massicot. Lead monoxide, PbO, occurring as a mineral. Contains 92.8 per cent lead (U. S. Geol. Surv.). *See* Litharge.

Massif. 1. The dominant, central mass of a mountain ridge more or less defined by longitudinal or transverse valleys. 2. A diastrophic block, or any isolated central independent mass. (Standard)

Massifs longs. (Fr.) Pillars in longwall workings. (Gresley)

Massive. 1. In petrology, (*a*) of homogeneous structure, without stratification, flow-banding, foliation, schistocity, and the like; said of the structure of some rocks: often, but incorrectly used as synonymous with igneous and eruptive. (*b*) Occurring in thick beds, free from minor joints and lamination: said of some stratified rocks. 2. In mineralogy, without definite crystalline structure; amorphous: not a very good usage. (La Forge)

Massive eruption. The pouring forth of lava from a line or system of fissures, so that vast areas have become covered by nearly horizontal sheets of eruptive material. (Century)

Mast. The upright pole of a crane or derrick. (Standard)

Master. A collier's term for the owner of the mine. (Gresley)

Master joint. A large and persistent plane of division that passes with regularity and parallelism through a number of beds. (Power)

Master lode. The most productive lode of a district (Standard). *See also* Champion lode.

Master wasteman (Eng.). The person who has charge of the wastemen. (G. C. Greenwell)

Mastic. 1. A mixture of bituminous material and other fine mineral matter, for use in highway construction and for application in a heated condition. (Bacon)
2. A kind of mortar or cement used for plastering walls. It is composed of finely ground oölitic limestone mixed with sand, litharge and linseed oil. (Century)

Mat. 1. An accumulation of broken mine timbers, rock, earth, etc., coincident with the caving system of mining. As the ore is extracted the mat gradually settles and forms the roof of the working levels, stopes, etc. 2. A hempen blanket made of ropes to cover shallow excavations when blasting therein to prevent damage by flying rocks, etc.
3. A lusterless or dull surface in a metal, produced by a method of finishing. 4. A tool for finishing a metal surface so as to produce a neat appearance. (Standard)

Mata (Sp.). Matte; *M. azul*, blue metal. (Halse)

Metacho (Mex.). An unproductive lode. (Lucas)

Matas de oro (Sp.). Ore chimneys. (Lucas)

Match. 1. A charge of gunpowder put into a paper several inches long, and used for igniting explosives. 2. The touch end of a squib. (Steel)
3. In founding, a casing of hard sand, block of plaster, or the like, for guarding any deficiency in the matching or joining of the parts of a mold. (Standard)

Match plate. In founding, a board or plate placed between the parts of a two-part flask and on the opposite sides of which the halves of a pattern are placed and rammed up, the plate being then removed to permit the halves of the pattern to come together. (Standard)

Matera (Colom.). A bunchy mine, or one in which the gold is found in pockets. (Halse)

Material man (Corn.). One who has the care of materials and issues supplies to miners (Min. Jour.) A warehouse man.

Matheson joint. A wrought-pipe joint made by enlarging the one end of the pipe to form a suitable lead recess, similar to the bell end of a cast-iron pipe, and receiving the male or spigot end of the next length. Practically the same style of a joint as used for cast-iron pipe. (Nat. Tube Co.)

Mathewson's device. An apparatus for separating matte and slag at lead-silver blast furnaces where matte is of secondary importance. (Peters, p. 297)

Matrass; Mattrass. A small, hard, glass tube closed at one end, used in blowpipe analysis. (Webster)

Matrice. *See* Matrix.

Matricula (Sp.). A register for mines, etc. (Crofutt)

Matrix. 1. The rock or earthy material containing a mineral or metallic ore; the gangue (Raymond). Sometimes called Ground mass.
2. The material which forms a cushion, or binder, for use in the construction of pavements. (Bacon)
3. The impression or mold of the exterior of a fossil, crystal, or other mineral left in the containing rock when a fossil is removed, or the mass in which a fossil or mineral is embedded. (Standard)

Matrix jewelry. Jewelry cut from some stone, as opal or turquoise, and its surrounding matrix. Such mixtures are called opal matrix, turquoise matrix, etc. (Webster)

Matrix rock. Same as Land-pebble phosphate. (Power)

Matriz (Sp.). Matrix, gangue, or veinstone. (Halse)

Matte. A product obtained in smelting sulphide ores of certain metals, as copper, lead, or nickel. It is crude metal combined with more or less sulphur, and requires to be further purified. (Webster). A heterogeneous mixture of metallic sulphides produced in smelting sulphide ores. Matte is brittle and the fracture ranges from coarse grained through fine grained to conchoidal: its color is bronze-like, often bluish, again dark to a light gray; the luster is bright. The leading components are sulphur, copper, iron, lead, nickel; of secondary importance are zinc, cobalt, manganese, bismuth, and precious metals. As to the constitution of matte the freezing point curves show that there are present chemical compounds, eutectic mixtures and solid solutions (Hofman, General metallurgy, p. 884). Copper matte usually contains 30 to 40 per cent sulphur.

Matt glaze. A dull glaze applied to some burned clay products. (Ries)

Matting. The process of smelting sulphide ores into matte. (Weed)

Matting tool. *See* Mat, 4.

Mattock. 1. A miner's pickaxe. (Skinner)
2. An implement for digging and grubbing. The head has two long steel blades, one like an adz and the other like a narrow ax, or the point of a pickax. (Webster)

Matura diamond. 1. An inferior diamond from Matura, Ceylon, India.
2. A name given in Ceylon to zircon from the district of Matura. (Century)

Maturation. In alchemy, the conversion of a base metal into gold. (Webster)

Mature. Having reached the maximum vigor and efficiency of action or the maximum development and accentuation of form: said of streams, the sculpture of land by erosion, and the resultant topography. *Compare* Young and Old. (La Forge)

Mature river. A river in the third and most perfect stage of development.

Maturity. That stage in the development of streams or in land sculpture at which the process is going on with maximum vigor and efficiency or the maximum development and accentuation has been reached. *Compare* Youth and Old age. (La Forge)

Maul (Derb.). A large hammer or mallet. (Raymond)

Maundril (Derb. and Wales). A prying pick with two prongs (Raymond). Also spelled Mandrel, Mandril.

Maverick. Anything dishonestly obtained, as a saddle, mine, or piece of land. (Century)

Maxton screen. A screening machine of the trommel class, rotating on rollers that support the tube. There are radial elevating ribs, to prevent wear of screen cloth and to elevate the oversize. Unscreened material is delivered on the inside screen surface, undersize passing through and oversize being elevated and discharged into a separate launder. (Liddell)

Mayencian. A division of the Miocene Tertiary, typically developed in the Mainz (or Mayence) basin, Germany. (Standard)

Mayoral (Peru). A head overseer or boss. (Halse)

Mayordomo. 1. (Mex.) In the *patio* process, the chief of the muleteers.
2. (Peru) A foreman or boss. (Halse)

Maza (Sp.). A hammer; a stamp head. (Lucas)

Mazamorra (Colom.). 1. Imperfect or poor working of a placer mine. 2. An insignificant part of the ground sluice abandoned to poor people for the gold they can get out of it. (Halse)

Mazamorras (Bol.). Mud streams from the flanks of the Illimani mountain. (Halse)

Mazamorrear (Colom.). To wash gold. To glean. (Halse)

Mazamorrero (Colom.). A gold washer who works on his own account. (Halse)

Mazapilite. An arsenate of calcium and iron, closely related to arseniosiderite. Occurs in black prismatic crystals. (Century)

Mazo (Mex.). 1. Striking hammer.
2. Stamp for crushing ore. (Dwight)

Mazout; Marsut. A Russian petroleum product remaining after the distillation of benzine and kerosene. It is a brownish black liquid, and used largely as a fuel oil. (Webster)

Meadow ore. Bog iron ore. (Power)

Meander. One of a series of somewhat regular and looplike bends in the course of a stream, developed, when the stream is flowing at grade through lateral shifting of its course toward the convex sides of the original curves. (La Forge)

Meander line. A surveyed line, usually irregular, but not a boundary line (Webster). A traverse line.

Mean refractive index. The mean of the values of the index of refraction for the extreme red and the extreme violet rays. (Webster)

Mear; Meer. *See* Mere.

Measures. In geology, a group or series of strata having some characteristic in common, as coal measures; almost obsolete. (La Forge)

Measures head. A heading or drift made in various strata. (Gresley)

Measuring chain. A surveyor's chain, containing 100 links of 7.92 inches each. (Century)

Measuring day (Scot.). The day when the manager or other official measures the amount of work done in the mine. (Barrowman)

Meat earth. The vegetal mold.

Mecapal (Mex.). 1. Sheet-iron scraper used by ore sorters. 2. Flat strap or rope that goes over the head of an ore carrier to support the load. (Dwight)

Mecate (Mex.). Coarse twine. Twine made of Maguey fiber, or Ixtle. (Dwight)

Mecha (Mex.). 1. A fuse. 2. A wick for a lamp or a candle. 3. A torch (Dwight). *M. de seguridad*, safety fuse. (Lucas)

Mechanical efficiency. Mechanical efficiency of an air compressor is the ratio of the air-indicated horsepower to the steam-indicated horsepower in the case of a steam-driven, and to the brake horsepower in the case of a power-driven machine. (A. I. M. E., Bull. 140, p. lvii)

Mechanical mixture. A composition of two or more substances, each remaining distinct, and generally capable of separation by mechanical means. (Standard)

Mechanical puddlers. A stirring device by which a bath of molten metal is agitated by mechanical rabbles, to save hard labor. The term puddling, now applied in metallurgy exclusively to the above process, originally referred to the puddling of clay, or clay and charcoal, upon the masonry of a furnace hearth to form a lining. (Winchell)

Mechanical rabble. A rabble worked by machinery (Standard). *See* Rabble, 3.

Mechanics. The branch of physics that treats of the phenomena caused by the action of forces on material bodies. It is subdivided into *statics*, *dynamics*, or *kinetics;* or into the *mechanics of rigid bodies*, and *hydromechanics* (including *hydrostatics and hydrodynamics.*) (Standard)

Mechazo. (Sp.). A misfire, due to burning of fuse without exploding the charge. (Halse)

Media (Sp.). A medium sized drill. (Halse)

Media barreta (Peru). An inclined shaft. (Dwight)

Medial moraine. A moraine formed interiorly upon a glacial stem, by the coalescence of two lateral moraines of the coalescing glaciers (Standard). *See* Moraine.

Medida (Sp.). A measure; a standard gauge. (Halse)

Mediophyric. Moderately porphyritic rocks with phenocrysts between 5 mm. and 1 mm. in longest diameter. *See* Magnophyric and Minophyric. (Iddings, Igneous Rocks, p. 200)

Mediosilicic. In petrology, containing between 50 and 60 per cent silica: said of some igneous rocks; same as Intermediate. (La Forge)

Medir (Sp.). 1. To measure. 2. *M. una mina*, to survey a mine. (Halse)

Medium steel. Steel containing from 0.15 to 0.30 per cent of carbon. Used especially for structural purposes. (Webster)

Medjidite. A hydrous sulphate of uranium and calcium, occurring with uraninite. (Century)

Meend; Meand (Forest of Dean). Old ironstone workings at the outcrop, some of which were worked by the Romans. (Gresley)

Meerschaum; Sepiolite. A tough, compact, hydrous magnesium silicate. (U. S. Geol. Surv.)

Meet. 1. (Eng.) To keep pace with, for example, to keep sufficient supply of coal at the pit bottom to supply the winding engine. (Gresley) 2. To come together exactly, as in survey lines from opposite directions.

Meeting. 1. A siding or by-pass on underground roads. (Gresley) 2. (Newc.) The place at middle-depth of a shaft, slope, or plane, where ascending and descending cars pass each other. (Raymond)

Megabasite. A tungstate of iron and manganese, probably a variety of wolfram. (Century)

Megalith. One of the huge stones or bowlders used in various types of prehistoric monuments, such as the menhir, dolmen, etc. (Webster)

Megalithic masonry. Masonry in very large stones, whether wholly or partly rough. (Standard)

Megascopic. Large enough to be distinguished with the naked eye; the antithesis of microscopic. *See* Macroscopic. Used also to describe methods of observation without the microscope or with the eye alone. (Kemp)

Meionite. A vitreous, colorless to white, transparent to translucent, calcium-aluminum silicate, $Ca_4Al_6Si_6O_{25}$. Tetragonal. (Dana)

Meizoseismal. Of, or pertaining to, the maximum destructive force of an earthquake. (Standard)

Meizoseismal curve. A curved line connecting the points of the maximum destructive energy of an earthquake shock around its epicentrum. (Standard)

Mejora (Sp.). Improvement; *M. de boca*, an improvement or alteration made in the entrance to a mine. (Halse)

Melaconite. Black copper oxide, CuO. Contains 79.8 per cent copper. The name given to an earthy, black, massive variety of tenorite. (U. S. Geol. Surv.)

Melanchyme. A bituminous substance found in masses in the brown coal of Zweifelsruth, Bohemia. That part of this substance which is soluble in alcohol is termed rochlederite, the residue melanellite. (Bacon)

Melanellite. That portion of melanchyme which is insoluble in alcohol; it is black and gelatinous. (Bacon)

Melanite. A black variety of common garnet. (Dana)

Melanocratic. A name applied by W. C. Brögger to those eruptive rocks in which the dark or ferromagnesium minerals are in excess over the light ones. The antithetical term is leucocratic. Melanocratic is derived from two Greek words meaning the 'black prevails.' (Kemp)

Melanterite. Copperas; hydrous ferrous sulphate, $FeSO_4+7H_2O$. (Webster)

Melaphyre. 1. Any dark-colored felsitic igneous rock. 2. A basalt or fine-grained diabase whose original minerals have been partly or wholly altered to calcite, chlorite, epidote, limonite, etc.; now little used. 3. An olivine basalt of pre-Tertiary age: obsolete in this sense. (La Forge)

Melilite. An orthosilicate of sodium, calcium, aluminum, and other metals. It is a constituent of certain igneous rocks, replacing the feldspar (Webster). The name of the mineral is sometimes prefixed to the names of rocks containing it, as melilite-monchiquite. (Kemp)

Melilite-basalt. A rare basaltic rock whose feldspathoid is melilite. It was first identified by Stelzner in 1882. The rock is excessively basic. Almoite is the same rock in dikes. (Kemp)

Melinite. 1. A high explosive similar to Lyddite, said to be chiefly picric acid. (Webster)
2. A species of soft, unctuous clay, common in Bavaria, and probably identical with bole. (Standard)

Mell (Eng.). A large hammer. (Bainbridge)

Mellan (Braz.) *See* Cascalho.

Mellite. A mineral of honey color, found in crystals and granular masses in brown coal, partly as a result of vegetal decomposition; honey stone. $Al_2.C_{12}.O_{12}.18H_2O$. (Webster)

Mellowing. A change of color in building stone, due to oxidation of some ferruginous compound, or to absorption of impurities. (Standard)

Melonite; Tellurnickel. A nickel telluride, Ni_2Te_2. In indistinct granular and foliated particles. Color reddish-white, with metallic luster. (Dana)

Melt. 1. To reduce from a solid to a liquid state, usually by heat; to liquefy; to fuse. 2. A melted substance; also the mass melted at a single operation, or the quantity melted during a certain period. (Webster)

Melting furnace. A glass-makers' furnace in which the frit for the glass is melted before it goes to the blowing furnace. (Century)

Melting point. The degree of temperature at which a solid substance melts or fuses. (Webster)

Melting pot. A crucible. (Standard)

Member. In the usage of the U. S. Geological Survey, a division of a formation, generally of distinct lithologic character or of only local extent. (La Forge)

Memoria (Mex.). 1. Pay roll. 2. A weekly account of mine expenses. (Halse)

Mena (Mex.). A mineral vein; ore. *M. crudo*, raw or crude ore; *M. grueso*, ore in large lumps; *M. recio*, massive ore. (Halse)

Menaccanite. A synonym for Ilmenite.

Ménage (Fr.). A club of working men in Scotland and North England (Century). Common in mining districts.

Mend (Eng.). To lead, or reload, trams at the gate-ends out of smaller trams used only in the working faces of thin seams. (Gresley)

Mendeleeff group. In chemistry, one of the groups into which the elements are classified in the periodic system. (Webster)

Mendeleeff's law. *See* Periodic law.

Mendits (Fr.). Same as Putters. Trammers. (Gresley)

Mendozite. A massive, fibrous, white, hydrous, sodium-aluminum sulphate, $NaAl(SO_4)_2+12H_2O$. Called also Alunogen and Soda alum. (Dana)

Meneghinite. A lead-antimony sulphide mineral. $4PbS.Sb_2S_3$. Orthorhombic. In slender prismatic crystals; also massive. Color blackish lead-gray. (Dana)

Menilite. A concretionary, opaque, dull, grayish variety of opal. (Dana)

Meniscus. 1. A lens concave on one side and convex on the other, especially when of true crescent-shaped section. 2. The surface of a liquid column. Its curvature is determined by the surface tension, being concave when the walls are wetted by the liquid and convex when not. (Webster)

Men on! (Scot.). A brief expression to indicate that men are on the cage to be raised, or lowered, in the shaft. (Barrowman)

Menucos (Arg.). Dangerous bogs usually hidden by a luxuriant vegetation. (Halse)

Mephitic. Foul; noxious; poisonous; stifling. (Century)

Mephitic air. An old name for carbon dioxide (Webster). Black damp; choke damp.

Mephitis. A noxious exhalation caused by the decomposition of organic remains: applied also to gases emanating from deep sources, as in mines, caves, and volcanic regions. (Standard)

Mercantile system. A theory in political economy that wealth consists not in labor and its products, but in the quantity of silver and gold in a country, and hence that mining, the exportation of goods, and the importation of gold should be encouraged by the State: held generally up to the close of the 18th century. (Standard)

Merced (Sp.). A gift. This term is applied to a grant that is made without any valuable consideration. (Raymond)

Merchant bar. *See* Merchant iron.

Merchant iron. Iron in the common bar form, convenient for the market. Called also Merchant bar. (Standard)

Merchant rolls. Finishing rolls in a merchant-iron mill (Standard). *See* Merchant train.

Merchant train. A train of rolls for reducing iron piles, or steel ingots, blooms, or billets, to bars of any of the various round, square, flat, or other shapes, known as merchant iron or steel. (Raymond)

Mercurial horn-ore. Same as Calomel. (Standard)

Mercurio (Sp.) 1. Mercury, or quicksilver. 2. Mercury ore. *M. córneo*, calomel. (Halse)

Mercury. A heavy, silver-white, liquid, metallic element; also called popularly quicksilver. Hydrargyrum. Symbol, Hg; atomic weight, 200.6; specific gravity, 13.54. (Webster)

Mercury arc. An electric arc transmitted by mercury vapor in a vacuum tube. (Webster)

Mercury cup. 1. The cistern of a mercury barometer. 2. A cup containing mercury for making an electric connection, as by dipping the ends of two wires in it. (Standard)

Mercury furnace. A furnace in which cinnabar is roasted in order to cause the pure mercury to pass off in fume, which is condensed in a series of vessels. (Century)

Mercury gatherer. A stirring apparatus that causes quicksilver, that has become floured or mixed with sulphur in amalgamating, to resume the fluid condition, through the agency of mechanical agitation and rubbing. (Century)

Mercury ores. Native mercury; cinnabar (sulphide). (Raymond)

Mercury trap. *See* Trap, 5.

Mere; Mear. 1. A boundary-line. 2. In Derbyshire, a measure of mining-claims of 29 or 31 yards (Standard). The discoverer of the lode was allowed to claim two meres.

Mere stake; Meer stake; Mear stake. A stake to mark the boundary of mining property. (Mander)

Merestone. A stone used as a boundary; also, figuratively, a boundary. (Standard)

Mergulhador (Braz.). In alluvial mining, a diver. (Halse)

Mergulhar (Braz.). To work alluvial sands by diving. (Halse)

Mergulho (Braz.). A method of diving for auriferous river sand, employed by poor miners. (Halse)

Meridian. A great circle on the surface of the earth, passing through the poles and any given place. (Webster). A north-and-south line. Called also Terrestial meridian. (Standard)

Merma (Mex.). Ore lost by abrasion during treatment or transportation. (Dwight)

Merohedral. In crystallography, having only a part of the planes required by the full symmetry of the form. (Standard)

Merrill filter-press. A variation of the plate-and-frame press. (Liddell)

Merrit plate. *See* Bloomery.

Mersey "yellow coal." A synonym for Tasmanite.

Mesa (Sp.). 1. A high, broad, flat table-land, bounded, at least on one side, by a steep cliff rising from lower land; a plateau; terrace; flat-topped hill. (Standard)
2. Concentration table. 3. The hearth of a furnace. (Dwight)

Mesabite. A name suggested by H. V. Winchell for the ocherous goethite found so abundantly on the Mesabi range, Minnesota. (Chester)

Mescal (Sp.). *See* Pulque.

Mesh. 1. One of the openings or spaces in a screen. The value of the mesh is usually given as the number of openings per linear inch. This gives no recognition to the diameter of the wire, so that the mesh number does not always have a definite relation to the size of the hole. (Richards)
2. Engagement, or working contact, of the teeth of wheels or of a wheel and rack. (Webster)

Mesh structure. A structure resembling network or latticework found in certain alteration products of minerals. Called also Net structure, Lattice structure. (Standard)

Mesitine spar. Mesitite; a carbonate of magnesium and iron, $2MgCO_3$-$FeCO_3$. (Dana)

Mesitite. *See* Mesitine spar.

Mesole. Same as Thompsonite.

Mesolite. A mineral intermediate between natrolite and scolecite. In acicular and capillary crystals; delicate divergent tufts, etc. White or colorless. Occurs in amygdaloidal basalt at numerous places. (Dana)

Mesolithic. Designating a stage of culture intermediate between the Paleolithic and Neolithic. (Webster)

Mesosiderite. A variety of meteorite. (Standard)

Mesostasis. A synonym for Basis, suggested by Gümbel. (Kemp)

Mesothermal. Of, having, or pertaining to a medium temperature. (Webster)

Mesothorium. A radio-active element found in monazite sand and other thorium minerals. First identified and described by Hahn in 1905. It is a substitute for radium in the manufacture of certain luminous paints, and for medicinal purposes.

Mesotype. A variety of natrolite. (Dana)

Mesozoic. One of the grand divisions or eras of geologic time, following the Paleozoic and succeeded by the Cenozoic era, comprising the Triassic, Jurassic, and Cretaceous periods. Also the group of strata formed during that era. (La Forge)

Mesquite (Sp.-Mex.). A mimosaceous tree or shrub of the southwestern United States and Mexico, often forming dense thickets and frequently constituting the only arborescent vegetation of a region. It has pinnate leaves, small, fragrant flowers in a dense raceme, and bean-like pods that are rich in sugar and form an important food for stock. (Webster)

Mess kit. The cooking and table utensils for a mess, with the receptacle in which they are packed for transportation. (Webster)

Meta. In petrology, when used as a prefix to the name of a rock, signifies that the rock has undergone more or less change in mineral or chemical composition through metamorphism. (La Forge)

Metabalite. Wadsworth's name for altered, glassy trachytes, of which lassenite is the unaltered form. (Kemp)

Metachemical metamorphism. Dana's term to describe that variety of metamorphism which involves a chemical change in the rocks affected. (Kemp)

Metacinnabarite. A mineral having the same composition as cinnabar, but black in color, and crystallizing in isometric forms (tetrahedral). *See* Cinnabar. (U. S. Geol. Surv.)

Metaclase. A rock possessing cleavage secondarily developed during rock deformation. *Compare* Protoclase. (C. K. Leith, Bull. 239, U. S. Geol. Surv., p 12)

Metacryst. A well-developed crystal of a secondary mineral, like garnet, staurolite, or andalusite, resembling a phenocryst, imbedded in the groundmass of a comparatively fine-grained metamorphic rock. (La Forge)

Metadiabase. A shortened form of metamorphic diabase, suggested by Dana for certain rocks simulating diabase, but supposed to have been produced by the metamorphism of sediments. *Compare* Pseudo-diabase. (Kemp)

Metadiorite. Dioritic rocks produced as described under metadiabase. *Compare* Pseudo-diorite. (Kemp)

Metal. 1. Any of a class of substances that typically are fusible and opaque, are good conductors of electricity, and show a peculiar metallic luster, as gold, bronze, aluminum, etc. Most metals are also malleable, and comparatively heavy, and all except mercury are solid at ordinary temperatures. Metals constitute over three-fourths of the recognized elements. They form oxides and hydroxides that are basic, and they may exist in solution as positive ions. 2. Ore from which a metal is derived. (Webster)
3. (No. of Eng.) In coal mining, indurated clay or shale. *See* Bind. (Gresley)
4. Cast iron, more particularly while melted. 5. Broken stone for road-surfaces or for railway ballast. 6. molten glass. 7. Railway rails. (Standard)
8. Copper regulus or matte obtained in the English process. The following varieties are distinguished by appearance and by their percentage of copper (here given in approximate figures); *Coarse*, 20 to 40; *red*, 48; *blue*, 60; *sparkle*, 74; *white*, 77; *pimple*, 79. *Fine metal* includes the latter four varieties. *Hard metal* is impure copper containing a large amount of tin. 9. (Scot.) All the rocks penetrated in mining ore. 10. *Road metal*, rock used in macadamizing roads. (Raymond)

Metal (Sp.). This term is applied both to the ore and to the metal extracted from it. It is sometimes used for vein, and even for a mine itself (Raymond). *M. azul*, lead ore. *M. crudo* (Peru), oxidized ore. *M. de ayuda*, fluxing ore of any kind. *M. de beneficio*, second class ore worked on the patio. *M. de cebo*, rich ore, usually treated in small reverberatory furnaces. *M. de correr*, pure tin ore. *M. de exportación*, first-class ore ready for sale. *M. de fuego*, smelting ores. *M. de labores*, smalls from the workings of the mine. *M. de pie*, ore amenable to the *patio* process. *M. de primera clase*, first-class ore ready for sale. *M. de quema* (Peru), sulphide ore. *M. en barras*, bullion. *M. en piedra* (Peru), crude ore. *M. gabarro*, first and second-class ore, from the size of an egg to that of an orange. *M. granza*, fine ore, smalls. *M. hecho*, hand-picked, rich ore. *M. jugoso*, wet ore, *i. e.*, lead ore. *M. negro*, blende. *M. ordinario*, common ore. *M. de pepena*, the best class of selected ore. (Halse)

Metalada (Mex.). Discovery of ore in a barren working. (Dwight)

Metal bath. A bath, as of mercury, or tin, employed for chemical processes requiring great heat. (Standard)

Metal drift (Lanc.). A heading driven in stone. (Gresley)

Metaled. 1. Surfaced with stone; macadamized: said of an ordinary road. 2. Stone ballasted: said of a railway. (Standard)

Metales (Sp.) Ores extracted from a mine. *M. calidos*, minerals capable of amalgamation. (Lucas) *M. de fundición*. Ores for smelting (Min. Jour.) *M. humildes* (Peru) Silver ores that amalgamate readily without sickening or flouring the mercury. (Dwight) *M. frios*, minerals unsuitable for amalgamation. *M. nobles*, free milling ores; noble ores. (Lucas)

Metalifero (Sp.). Metalliferous. (Lucas)

Metaline. A trade name for a metallic, dark-colored compound or alloy, used in the form of plugs inserted into holes drilled into machine bearings, for obviating friction, and as a substitute for ordinary lubricants. (Webster)

Metalist. One who works in, or has special knowledge of, metals (Standard). A metallurgist.

Metallic. 1. Of or belonging to metals, containing metals, more particularly the valuable metals that are the object of mining. (Rickard)
2. Applied to minerals having the luster of a metal, as gold, copper, etc. (Dana)

Metallic iron. Metal-iron, as distinguished from iron ore. (Standard)

Metallic luster. A luster characteristic of metals in a compact state, and shown also by some other substances, as certain minerals and dyes. It is due to more or less of selective absorption in the surface layer, combined with a strong reflection. The blackness of finely divided metals is explained as due to repeated reflection and absorption of light among the particles. (Webster)

Metallic oxides. Those oxides that consist of a metallic element and oxygen, and are for the most part basic. (Standard)

Metallic sulphide. A sulphide in which the basic radical is a metal: applied chiefly to certain minerals, as iron sulphide (pyrite), zinc sulphide (blende), etc. (Standard)

Metallic tremor. The trembling palsy of metal workers, as of workers with lead or quicksilver; the mercurial-trade disease. (Standard)

Metalliferous. Producing or containing metal; yielding metal. (Webster)

Metallify. To convert into metal. (Webster)

Metalline. 1. Pertaining to or resembling a metal. Metallic. 2. Impregnated with metallic salts, as *metalline* water. (Webster)

Metallites. A word used by M. E. Wadsworth to embrace all ores or metalliferous material. (Power)

Metallize. To turn into a metal; to infuse mineral or metallic particles into as the pores of wood. (Standard)

Metallography. 1. The science or art of metals and metal working; also a treatice on metals. 2. The microscopic study of the structure of metals and their alloys. It utilizes the light reflected by polished surfaces.

Metallization. The process, or group of processes, whereby valuable metals, or minerals containing such metals, are introduced into the rocks. The term *mineralization* is often used in the above sense and is really more comprehensive. The formation of garnet in limestone, for example, is a result of mineralization but may have no economic significance whatever. (Ransome)

Metalloid. 1. An alkali metal, as sodium, or an alkaline-earth metal, as calcium; so called by Davy because not supposed to be well-defined metals. 2. Certain elements, as arsenic, antimony, that share the properties of metals and nonmetals. 3. Having the appearance of a metal. (Webster)

Metallurgical engineer. Any one versed in the principles of metallurgy, including inorganic chemistry and general engineering, and who applies them on a commercial scale in any of the processes for the extraction of metals from their ores, or from alloys.

Metallurgical fume. A mixture of fine particles of elements and metallic and nonmetallic compounds either sublimed or condensed from the vapor state. In practice, it usually has mixed with it small proportions of fine flue dust. Moreover, fume may consist of very small, solid particles and of very small liquid particles, the latter like a mist or fog. The composition of metallurgical fume varies within wide limits,

dependent upon the method of smelting employed. (Fulton, p. 32, Bull. 84. Bu. Mines). *See also* Fume.

Metallurgical smoke. A term applied to the gases and vapors, and fine dust entrained by them, that issue from the throat of blast furnaces, reverberatory smelting furnaces, or roasting furnaces. It consists of three distinct substances, gases, (including air), the flue dust, and the fume. (Fulton, p. 8, Bull. 84, Bu. Mines)

Metallurgist. One who is skilled in, or who practices metallurgy. *Compare* Metallurgical engineer.

Metallurgy. The science and art of preparing metals for use from their ores by separating them from mechanical mixture and chemical combination. It includes various processes, as smelting, amalgamation, electrolytic refining, etc. Metallurgy, as generally understood, is concerned with the production of raw metallic materials, the manufacture of which, into finished articles, belongs to other arts. (Webster)

Metal man. 1. (Lanc.) One who repairs underground roads. (Gresley)
2. One who works in metals. (Standard)

Metal-notch. *See* Tap hole, 1.

Metal ridge (No. of Eng.). 1. A pillar or pillars that form a support for a mine roof. (Gresley)
2. (Eng.). The strata forced up by a creep. (Bainbridge)

Metals (Scot.). A general name for the strata in which minerals occur. (Barrowman)

Metal stone (Newc.). Argillaceous stone. Shale and sandstone. (Min. Jour.)

Metameric. Having the same elements united in the same proportions by weight, and with the same molecular weights, but with different structure or arrangement of the ultimate parts. (Power)

Metamórfico (Sp.). Metamorphic.

Metamorphic. Characteristic of, pertaining to, produced by, or occurring during metamorphism. (La Forge) Said of certain rocks.

Metamorphism. In geology, any change in the texture or composition of a rock, after its induration or solidification, produced by exterior agencies, especially by deformation and by rise of temperature. The processes and results of cementation and of weathering are not ordinarily included. (La Forge). The most important agents are *heat, moisture* and *pressure.*

Metamorphosis. Change of form, structure or substance; transforation of any kind. (Webster)

Metamorphous. Same as Metamorphic.

Metapepsis. Regional metamorphism, due to steam or boiling water under great pressure; a term proposed by G. H. Kinahan (Standard). Also called Parotepsis.

Metapil (Mex.). The grinding stone of an arrastre, etc. (Dwight)

Metasilicate. A salt of metasilicic acid; especially applied to certain minerals more frequently called bisilicates. (Standard)

Metasomatic. In geology, characteristic of, pertaining to, produced by, or occurring during metasomatosis. (La Forge.) The term is especially used in connection with the origin of ore deposits. The corresponding noun is metasomatosis, but 'replacement' is a good English equivalent. (Kemp)

Metasomatosis; Metasomatism. Chemical alteration of a mineral or a rock; the replacement of a mineral by another through chemical action. (La Forge)

Metasome. An individual mineral developed in another mineral. (Lindgren, p. 158)

Metate (Mex.). An iron bucking board for grinding ore samples. (Dwight)

Metatropy. A change in the physical character of a rock mass while there is no essential change in its constituents, *e. g.*, the vitrification and devitrification of rocks. (Power)

Metaxite. 1. Hauy's name for micaceous sandstone. (Kemp)
2. A fibrous serpentine. (Webster)

Meteoric iron. Iron found in meteors; also, an iron meteorite. (Standard)

Meteoric stone. A meteorite, especially one of a stony composition or appearance. (Standard)

Meteoric water. Water that previously existed as atmospheric moisture, or surface water, and that entered from the surface into the voids of the lithosphere. (Meinzer)

Meteorite. A stony, or metallic, body that has fallen to the earth from outer space; an Aërolite. (Webster)

Meter; Metre. 1. An instrument, apparatus, or machine for measuring fluids, gases, electric currents, grain, etc., and recording the results obtained; as, a gas *meter;* a water *meter;* an air *meter.* 2. The fundamental unit of length in the metric system, originally defined as one ten-millionth of the distance on the earth's surface from the pole to the equator, now as the distance between two lines on a certain metallic rod preserved in the archives of the International Metric Commission at Paris (Standard). It is equal to 39.37079 inches.

Meter oil. An oil of low cold-test, like the light lubricating oils from Texas crude oil. (Bacon)

Methane. A gaseous hydrocarbon, CH_4, light odorless, inflammable, occurring naturally as a product of decomposition of organic matter in marches and mines, and produced artificially by dry distillation of many organic substances. (Webster)

Methanephone. An instrument for detecting methane in mine air. It contains an electric battery that sustains a small electric glow-light. As soon as a certain percentage of methane enters the workings a tiny explosion occurs in the fuse head, where a fine wire filament is melted and starts a bell to ringing continuously. (Coal Age, Mar. 30, 1918, p. 579)

Methanometer. An instrument, resembling a eudiometer, to detect the presence and amount of methane, as in coal mines. (Webster)

Metra. A pocket implement combining the uses of many instruments, as thermometer, level, plummet, and lens. (Standard)

Metric carat. A unit of weight, 200 mg., for weighing precious stones. *See also* Carat, 3. (Webster)

Metric system. A system of weights and measures depending upon the meter, in which the original factors are derived from the meter. The system includes measures of length, of which the *meter* is the unit; measures of surface, of which the *are* is the unit; measures of capacity of which the *liter* is the unit; and weights, of which the *gram* is the unit. (Standard)

Metric ton. One thousand kilograms, equal to 2204.6 avoirdupois pounds. (Webster)

Mett (Scot.). An old measure of capacity for coal. (Barrowman)

Mexican onyx. A variety of calcite, chiefly from Tecali, Mexico, used for interior decorations (Standard). *See also* Onyx marble.

Mexican tile. A term sometimes applied to roofing tile of semicircular cross section. (Ries)

Meymacite. A resinous, light-brown hydrated tungstic oxide, $WO_3.H_2O$, that is formed by the alteration of scheelite. (Dana)

Mezcla (Mex.). 1. Furnace charge. 2. Mortar. (Dwight)

Meso; Meso. A term sometimes prefixed to the names of igneous rocks of Mesozoic age. (Kemp)

Mezzamajolica (It.). A decorated and glazed earthenware made in Italy prior to the introduction of the majolica ware. The figures on it are traced in blue or black, the flesh is white, and the draperies are blue. (Standard)

Miamia (Aust.). A screen of brushwood, supported on poles, and placed near a shaft to protect the men from the weather. (Davies)

Miargyrite. A sulphide of antimony and silver, occurring in monoclinic crystals of an iron-black color with a dark, cherry-red streak. (Century)

Miarolitic. In petrology, containing small interstitial cavities, formed when the rock solidified, into which small crystals may project: said of some igneous rocks. Also, characteristic of, pertaining to, or occurring in such cavities. (La Forge)

Miaseite. A name coined from Miask, a locality in the Ural where a nephelite-syenite occurs whose dark silicate is biotite. Used also as a general name for biotitic nephelite-syenites. (Kemp)

Mica. A hydrous silicate having a very fine basal cleavage that renders it capable of being split into thin, tough, transparent plates. The most common varieties are *muscovite* and *biotite.* Phlogopite and lepidolite are prominent locally. (U. S. Geol. Surv.)

The name of the mineral is often prefixed to the name of the rock con-

taining it, as, mica-basalt, mica-tinguaite, mica-trachyte, etc. (Kemp). Called also Isinglass, Muscovy glass.

Micaceo-calcareous. Containing mica and calcite. (Standard)

Micaceous. Characteristic of, pertaining to, composed of, or containing mica. (La Forge)

Micaceous iron ore. A variety of hematite. (Power)

Mica diorite. A variety of diorite in which mica replaces hornblende. (Standard)

Micanite. An easily molded, prepared form of, mica used for insulating (Webster). A trade term.

Mica-peridotite. A variety of peridotite, consisting chiefly of altered olivine and biotite. (Kemp)

Micaphyre. A porphyry containing mica phenocrysts. (Webster)

Micapizarra (Sp.). A schist. (Halse)

Mica powder. A dynamite in which the dope consists of fine scales of mica.

Mica schist. A foliated, crystalline metamorphic rock composed of alternate layers of quartz and mica in various proportions, the typical one being about two-thirds quartz to one-third mica; although the proportion of the latter generally appears greater than it is, because the rock splits along the mica folia, thus showing the mica along on the flat surfaces. The true composition may be seen by looking at the squarely broken edges. (Roy. Com.) *See also* Schist.

Mica slate. A slate composed chiefly of fine mica. (La Forge)

Micatization. A metamorphic alteration of other material into mica. (Standard)

Mica trap. An English field name for dark, dike rocks rich in mica. (Kemp)

Mice-eaten quartz. Quartz full of holes, once occupied by sulphides, now decomposed and gone. (Davies)

Michigamme jasper. A highly altered ferruginous rock, usually carrying apparently fragmental quartz grains, found at Michigamme Mountain, Mich. (Ore Dep., p. 137)

Micro. Small. In lithology, indicating that the structure designated is so minutely developed as not to be recognized without the help of the microscope. (Century)

Microchemical tests. Chemical tests made on minute objects under a microscope. The form, color, and optical properties of the minute crystals are also used.

Microclastic. Clastic or fragmental, as rock composed of minute particles. (Standard)

Microcline. A mineral of the feldspar group, like orthoclase or common feldspar in composition, but triclinic in form. (Webster)

Microcosmic salt. Sodium-ammonium-hydrogen phosphate, $HNaNH_4PO_4 \cdot 4H_2O$ (Liddell). Also called Stercorite.

Microcrystalline. Minutely crystalline: said of crystalline rocks of which the constituents are individually so minute that they cannot be distinguished from each other by the naked eye; cryptocrystalline. (Century)

Microcrystallitic. Of, or pertaining to, a metamorphic rock in which the devitrification has continued until the original glassy material has changed into little granules, needles, and hairs. (Standard)

Microdiabase. A name given by Loosen to aphanitic diabases. (Kemp)

Microdiorite. A name originally given by Lepsius to a fine-grained diorite-porphyry. (Kemp)

Microfelsite. A name used in microscopic work for those varieties of groundmass that do not affect polarized light, but that are not true glasses because they have a fibrous, a granular or some such texture. The textures are no doubt in many cases the results of devitrification of a glassy base. (Kemp)

Microfelsitic. The designation suggested by Zirkel for a devitrified glass when the devitrification has been carried so far that the hyaline character is lost, but not far enough to give rise to the development of distinctly individualized mineral forms. (Century)

Microfluidal. In petrology, having or consisting of a microscopic flow-structure. (Standard)

Microfoliation. Foliation distinctly visible only under the microscope. (Webster)

Microgeology. That part of geology relating to features that require microscopic study. (Webster)

Microgranite. A name used in microscopic work for those groundmasses of porphyritic rocks that consist of small quartz and feldspar crystals with granitoid texture on a small scale, *i. e.*, with components of about the same size and usually without crystallographic boundaries. *See* Granophyric. (Kemp)

Microgranitoid. In petrology, having microscopic granitoid structure. (Standard)

Microgranulite. The French equivalent of granophyric. (Kemp)

Micrographic. In petrology, having the composition and structure of graphic granite on a microscopic scale. (Standard)

Microlite. 1. Essentially a calcium pyrotantalate. Contains also small quantities of columbium, fluorine, tungsten, and other bases. Used as a gem. (U. S. Geol. Surv.)
2. A minute crystal, visible only under the microscope (Webster). A microlith. (Standard)

Microlith. One of the microscopic isotropic needle- and rod-shaped bodies found in vitrophyric rocks. (Standard)

Microlithic. Composed or constructed of small stones: opposed to Megalithic. (Standard)

Micromeritic. Of, or pertaining to, a crystalline structure so fine that it can only be recognized by a microscope. (Standard)

Micrometer. 1. An instrument for measuring very small angles or dimensions, generally used in connection with a microscope or telescope. There are a great variety of forms, but in nearly all the measurement is made by turning a very fine screw, which gives motion to a scale, spider-line, lens, prism, or ruled glass plate. 2. A micrometer-caliper or gage. (Standard)

Micromineralogy. Mineralogy based on the use of the microscope.

Micropegmatite. Microscopic pegmatite. A term applied to the groundmass of porphyritic rocks whose microscopic quartz and feldspar mutually penetrate each other. The several parts of the same crystal, though isolated, extinguish together. *See also* Granophyric. (Kemp)

Micropegmatitic. In petrology, same as micrographic, which is much better and which is replacing it. (La Forge)

Micropegmatitic texture. A microscopic intergrowth of two minerals, especially of quartz and feldspar in which one mineral contains particles of the other arranged in a more or less regular pattern which, from its fancied resemblance to certain ancient inscriptions has been called also "graphic texture." (Ransome)

Microperthite. A variety of rock-making feldspar composed of orthoclase thickly set with microscopic spindles or plates of albite (la Forge). It is common in gneisses. *Compare* Granophyric.

Microphylline. Composed of minute leaflets or scales. (Century)

Microphysiography. Same as Petrography. (Standard)

Micropoikilitic. A textural term suggested by G. H. Williams to describe those minerals that are speckled with microscopic inclusions of other minerals, having no definite relations to each other or to their host. Poikilitic is often spelled poïcilitic or pœcilitic. (Kemp)

Microporphyritic. Microscopically porphyritic. (Standard)

Microscope. An optical instrument, consisting of a lens, or combination of lenses, for making enlarged or magnified images of minute objects. (Webster)

Microscopic. Minute; perceivable only by the aid of a microscope.

Microsection. 1. A transparent, thin section of some substance mounted for examination with the microscope (Standard). 2. A thin section of rock so mounted for petrographic examination.

Microseism. A slight tremor or vibration of the earth's crust. (Standard)

Microseismometer; Microseismograph. An apparatus for indicating the direction, duration, and intensity of microseisms. (Standard)

Microspherulitic. In petrology, having a texture composed of minute spherulites, closely packed. (Standard)

Microstructures. The structural features of rocks requiring microscopic examination. (Standard)

Middle band. A stratum of rock, or more usually soft dirt, near the middle of a coal seam (Steel). *See* Middle man.

Middle man. A stratum of rock dividing or separating two seams or beds of coal. (Sloss-Sheffield Steel & Iron Co. *v.* Edwards, 70 Southern, p. 286). *See* Middle band.

Middles (Eng.) A variation of middling.

Middletonite. A brown, resinous, brittle mineral found between layers of coal at the Middleton collieries, near Leeds, England, and also at Newcastle; it has a specific gravity 1.6, does not alter at 210° C., and is soluble in cold concentrated sulphuric acid. (Bacon)

Middling. The second quality of ore obtained by washing. Usually used in the plural form. *See* Head, 10; *also* Slime; and Tailings. (Webster)

Middling-pale solder. An alloy of tin, lead, and bismuth; used by pewterers. (Standard)

Mid-door (Scot.). The middle one of three landing places in a shaft. (Barrowman)

Mid-feather. 1. (Derb.) Stringers of ore connecting two larger bodies. (Hooson)
2. A support to the center of a tunnel. (Standard)

Midges (No. of Eng.). Lamps (not safety) carried by trammers, etc. (Gresley)

Mid-wall (Scot.) A close wooden partition dividing a shaft into compartments. (Barrowman)

Mid-workings. 1. (Scot.) Mine workings above or below in the same mine or colliery (Gresley). 2. *See* Mid-door.

Miersite. A bright-yellow silver iodide, AgI, which crystallizes in the isometric system. (Dana)

Miesite. A brown variety of pyromorphite that contains calcium. (Standard)

Mijakite. An andesite from the Japanese island of Mijakeshima, from which the name is derived. It is porphyritic with phenocrysts of bytownite, augite, hypersthene, and biotite. In the groundmass are brown pyroxene, feldspar, and basis. Largely on the results of the chemical analysis, the brown pyroxene is believed to be a manganese-bearing, triclinic variety related to babingtonite, hence the new name for the rock. (Kemp)

Mil. In electricity, a unit of length in measuring the diameter of wire; 1/1000 inch (Standard). *See* Circular mil.

Milarite. A vitreous, colorless to greenish, brittle, hydrous, potassium-calcium-aluminum silicate, $HKCa_2Al_3(Si_2O_5)_6$. In hexagonal prisms. (Dana)

Mild, or Soft steel. Steel containing less than 0.15 per cent of carbon. Highly ductile and is used for boiler plates, etc., (Webster). *See also* Steel.

Mild and tough. Mellowed or ripened by weathering; said of brick clay; opposite of Short and rough. (Standard)

Mildewbronze. Bronze made to look as if mildewed by long burial underground. (Standard)

Mile (Eng. and U. S.). A measure of length equal to 5,280 feet, 1,760 yards, 880 fathoms, 80 chains, 1,609.3 meters.

Milkstone. 1. Any of various white stones, as flint pebble. (Webster)
2. A flint whitened by fire, found among prehistoric remains. (Standard)

Milky quartz. Vitreous quartz of a milk-like color and of somewhat greasy luster; also called Greasy quartz. (Power)

Mill. 1. (Eng.) That part of an iron works where puddle-bars are converted into merchant-iron, *i. e.*, rolled iron ready for sale in bars, rods, or sheets. *See* Forge. 2. By common usage, any establishment for reducing ores by other means than smelting. More strictly, a place or a machine, in which ore or rock is crushed. *See* Machine 4. 3. An excavation made in the country rock, by a cross-cut from the workings on a vein, to obtain waste for filling. It is left without timber so that the roof may fall in and furnish the required rock. (Raymond)
4. A passage connecting a stope or upper level with a level below, intended to be filled with broken ore that can then be drawn out at the bottom as desired for further transportation. An opening in the floor or bottom of a stope through which the ore or mineral is passed or thrown downward along the footwall to

the level. (Lesh v. Tamarack Min. Co., 152 NW. Rept., p. 1022; 1916). 5. To fill a winze, or interior incline, with broken ore, to be drawn out at the bottom. (Webster)

Mill bar. A rough bar rolled or drawn directly from a bloom or puddle-bar for conversion into merchant iron in the mill. (Webster)

Mill car. A flat car on which is mounted a heavy hoisting engine. (Webster)

Mill cinder. The slag from the puddling furnaces of a rolling mill. (Raymond)

Mill coal (Kansas). Same as Dead coal.

Mill dirt (So. Afr.). Free milling ore. (Skinner)

Miller indices. Mathematical symbols for crystal faces. (A. F. Rogers)

Millerite. Nickel sulphide, NiS. Contains 64.1 per cent nickel. (U. S. Geol. Surv.)

Miller process. The separation of gold and silver by conducting chlorine gas into the molten metal. The silver and other base metals are chloridized and come to the top of the bath. (Liddell)

Mill furnace. An iron furnace for reheating iron that is to be re-rolled, or welded, under the hammer. (Standard)

Mill hole. An auxiliary shaft connecting a stope or other excavation with the level below (Ihlseng). *See* Mill, 4.

Milligram. A unit of weight in the metric system, equal to one thousandth part of a gram, 0.05432 grain, 0.000648 pennyweight, 0.00003215 troy ounce, and has a gold value of 0.06645 cent or 0.033 British penny. (Lindgren, p. 20)

Millimeter. A metric measure of length, equal to 0.0394 of an inch. (Webster)

Milling. 1. (Lake Superior District). A combination of open cut and underground mining, wherein the ore is mined in open cut and handled underground. It is underhand stoping applied to large deposits, wherein the ore is mined near the mouth of winzes or raises, and dropped by gravity to working levels below for transportation to the surface. Sometimes called Glory-hole-method (W. R. Crane). *See* Mill, 4 and 5. 2. Dressing ore in a mill. (Weed)

Milling ore. 1. A dry ore that can be amalgamated or treated by leaching and other processes; usually these ores are low-grade, free, or nearly so, from base metals (Morrison). 2. Any ore that contains sufficient valuable minerals to be treated by any milling process.

Millman. One who is employed in a mill, as in an ore-dressing plant.

Millón (Mex.). An ore pile. (Dwight)

Mill pick. A tool for dressing mill stones. (Century)

Mill race. The current of water that drives a mill wheel, or the channel in which it flows from the dam to the mill. (Century)

Mill rolls. The rolls through which puddled iron is run previous to being marketed (Standard). *See* Merchant-train.

Mill run (Pac.). 1. The work of an amalgamating mill between two clean-ups. 2. A test of a given quantity of ore by actual treatment in a mill. (Raymond)

Mill scale. The scale of ferric oxide that peels from iron during rolling. *Compare* Forge scale. (Standard)

Mill site. A plot of ground suitable for the erection of a mill, or reduction works, to be used in connection with mining operations. (U. S. Min. Stat., pp. 595-607)

Millstone. A hard tough stone used for grinding cereals, cement rocks, and other materials. Usually a coarse-grained sandstone or fine quartz-conglomerate. (U. S. Geol. Surv.)

Millstone grit. an old English name for the conglomeratic sandstone at the base of the Carboniferous Coal Measures. It was formerly more or less current in this country as a synonym for Pottsville conglomerate.

Mill tail. The current of water leaving a mill wheel after turning it, or the channel through which it runs; a tailrace. (Century)

Mill test. The determination of the metallic contents and recoverable metal in any given ore by the milling of a sufficient quantity to afford average milling conditions (Weed). *See* Mill run.

Millwright. One whose occupation is to build mills, or to set up their machinery. (Webster)

Mimesite. An obsolete synonym for Dolerite. (Kemp)

Mimetic. Imitative. Applied to crystals which, by twinning, resemble simple forms of a higher grade of symmetry. (Webster)

Mimetite. Lead chlorarsenate, $3Pb_3As_2O_8$. (U. S. Geol. Surv.)

Mimic. In mineralogy, the same as Mimetic.

Mimophyre. A name suggested by Elie de Beaumont in 1814 for metamorphosed, argillaceous rocks in which feldspars had developed, so that they resembled porphyries. Volcanic tuffs are a frequent original, but graywackes and arkoses have also yielded them. *Compare* Porphyroid. (Kemp)

Mina (Sp.). 1. A deposit of mineral. 2. Mine. *M. ahogada* (Colom.) A placer mine which has been covered by a fall of ground or by gravel or tailings from a mine situated above it (Halse). *M. alta*, a high mine; *M. capotera*, a mine with ore at a slight depth; *M. cargada*, mine abounding in stone; *M. cogollera*, a mine rich at outcrop but poor below; *M. de cacho*, an alluvial mine with fine gravel; *M. de cerro*, a mountain mine; *M. de cueva*, mine with pay ore covered by large blocks of rock; *M. de invierno* (Colom.), a mine workable only in the rainy season; *M. de oro corrido*, alluvial mine; *M. de sabana*, a high-lying mine; *M. de saca*, a mine in which pay gravel lies below the level of the adjacent water; *M. de saco*, ore deposits filling superficial cavities; *M. de sobresabana*, a mine lying higher than a 'sabana'; *M. de tonga*, a self-draining mine; *M. de tope*, a mine in which ore is abundant in small places, the adjacent places being barren; *M. de verano* (Colom.) a mine workable only in the dry season; *M. de veta*, a lode mine; *M. en frutos*, a productive mine; *M. hervida*, an alluvial mine in which gold-bearing gravel was deposited by a whirlpool; *M. jornalera*, a poorly-paying mine; *M. matera*, a mine in which ore is abundant in small places, the adjacent places being barren. (Lucas)

Minable. That can be mined. (Standard)

Minado (Sp.). Underground workings. (Halse)

Minar (Sp.). To mine. (Halse)

Minargent. An alloy of copper, nickel, and antimony, with a slight proportion of aluminum. (Standard)

Mine. 1. In general, any excavation for minerals. More strictly, subterranean workings, as distinguished from quarries, placers, and hydraulic mines, and surface or open works. The distinction between the French terms *mine* and *minière* results entirely from the law, and depends upon the depth of the working. The former is the more general term, and, ordinarily speaking, includes the latter, which signifies shallow or surface workings (Raymond). *Compare* Quarry. NOTE: The word "mine" in statutes prescribing safety appliances and protection for the miner, has generally been held as including not only a place where pay ore has been discovered, but one where an excavation alone exists, as a cross-measures heading, an incline communicating with two or more seams or veins, or a trial heading, drift, adit, or shaft, etc., to prove the existence of minerals; in fact, any excavation for the development of a mineral deposit, or for the extraction of the ore, rock or coal therefrom. In a military sense, a mine is a subterranean gallery run under an enemy's works, to be subsequently exploded.

2. Any deposit of mineral or ore suitable for extraction, as an ore deposit. The Federal and State courts have held that the word "mine", in statutes reserving mineral lands, included only those containing "valuable mineral deposits". In England the term mine is applied to any seam of coal, as well as to a deposit of ironstone either in thin bands, or in one bed of considerable thickness.

3. The terms "mine" and "coal mine" are intended to signify any and all parts of the property of a mining plant, either on the surface or underground, that contribute directly or indirectly to the mining or handling of coal. (Hakanson *v.* La Salle County Carbon Coal Co., 106 N. E. Rept., p. 618; Spring Valley Coal Co. *v.* Greig, 129 Illinois App., p. 391; 226 Illinois, p. 511; Moore *v.* Dering, 242 Illinois, p. 87)

4. The term "mine," as used by quarrymen, is applied to underground workings having a roof of undisturbed rock. It is used in contrast with the "open-pit" quarry. (Bowles)

5. To dig a mine; to get ore, metal, coal, or precious stones out of the

earth; to dig in the earth for minerals; to work in a mine. (Webster)
6. *Discovery of a mine*: In statutes relating to mines the word "discovery" is used, (1) in the sense of uncovering or disclosing to view ore or mineral; (2) of finding out or bringing to the knowledge the existence of ore or mineral, or other useful products which were unknown, and (3) of exploration, that is, the more exact blocking out or ascertainment of a deposit that has already been discovered. In this sense it is practically synoymous with Development, and has been so used in the U. S. Revenue Act of February 9, 1919 (Sec. 214, subdivision A 10, and Sec. 234 subdivision A 9) in allowing depletion to mines, oil and gas wells.
Article 219 of "Income and War Excess Profits Tax Regulations" No. 45, construes "discovery of a mine" as, (1), the bona fide discovery of a commercially valuable deposit of ore or mineral, of a value materially in excess of the cost of discovery in natural exposure or by drilling or other exploration conducted above or below the ground; (2) the development and proving a mineral or ore deposit which has been apparently worked out * * * to be a minable deposit of ore or mineral having a value materially in excess of the cost of improving or development.

Mine captain. The director of work in a mine, with or without superior officials, and with or without subordinates. (Webster)

Mine dial. *See* Miner's dial.

Mine dust. 1. (Scot.) The riddlings of calcined ironstone. (Barrowman) 2. *See* Coal dust. 3. Dust from rock drills, blasting, or handling rock.

Mine earth (No. Staff.). Synonymous with Ironstone in beds. (Gresley)

Mine ground (Eng.). Strata containing ironstone in layers. (Gresley)

Mine locomotive. A low, heavy, haulage engine, designed for underground operation; usually propelled by electricity, gasoline, or compressed air.

Mine measures (Forest of Dean). *See* Mine ground.

Mine pig (Eng.). Pig-iron made wholly from ore, in distinction from cinder pig. (Webster)

Miner. 1. One who mines; one engaged in the business of getting ore, coal, or precious stones out of the earth; broadly, any one working underground in a mine; more narrowly, one who drills, blasts, stopes, drives levels, etc., in a mine. (Webster)
2. A worker in a coal mine who is paid a certain price for each ton of coal he digs or blasts from the solid seam, as distinguished from the laborer who loads the cars, etc. His *helpers* load the coal; they are also called Laborers. (Steel)
3. Includes all classes and laborers who work in a mine whether digging coal, timbering, or making places safe. (Driza *v.* Jones & Adams Co. 171 Illinois App., p. 145)

Mineral. 1. A mineral is a body produced by the processes of inorganic nature, having a definite chemical composition and, if formed under favorable conditions, a certain characteristic molecular structure, is exhibited in its crystalline form and other physical properties. A mineral must be a homogeneous substance, even when minutely examined by the microscope; further, it must have a definite chemical composition, capable of being expressed by a chemical formula. (Dana)
2. As used in flotation the terms 'mineral' or 'metallic' particles hark back to the French (*minéral*, ore) and Spanish (*metal*, ore) meanings. Both terms refer to those valuable constituents in the ore that it is the object of the process to separate from the non-valuable constituents, or gangue. (Rickard)
3. (Lake Superior) Concentrates containing about 65 per cent metallic copper. The crude ore is called *rock*.
4. In miner's parlance, ore (Hanks). *Compare* Ore.
5. The term mineral, when employed in a conveyance, is understood to include every inorganic substance that can be extracted from the earth for profit whether it be solid, as rock, fire clay, the various metals and coal, or fluid, as mineral waters, petroleum, and gas. (Horace Creek Land and Min. Co. *v.* Midkiff (W. Va.), 95 S. E. Rept., p. 27)

Mineral (Sp.). 1. Mineral or ore; *M. de bolsadas*, spotty or bunchy ore; *M. de crestón*, outcrop ore; *M. desmenuzable*, earthy ore, friable ore; *M. en roca*, rocky ore; *M. pobre*, low-grade ore, leavings; *M. rico*, high-grade ore; *M. tostado*, roasted ore. (Halse)

2. (Mex.) A mining district; also a mine. (Lucas)

Mineral adipocire. *See* Hatchettite.

Mineral belt. The strip, or zone, of mineralized territory in a given formation or district. (Weed)

Mineral blossom. Drusy quartz. (Power)

Mineral blue (Eng.). Azurite when reduced to an impalpable powder for use as a pigment.

Mineral borer (Scot.). A person whose business it is to search for minerals by boring. (Barrowman)

Mineral caoutchouc. *See* Elaterite, Helenite, and Caoutchouc.

Mineral charcoal. A pulverulent, lusterless substance, showing distinct vegetal structure, and containing a high percentage of carbon with little hydrogen and oxygen, occurring in thin layers in bituminous coal. (Raymond) Called by miners Mother of coal.

Mineral coal. A name for native coal, to distinguish it from charcoal. (Chester)

Mineral cotton. *See* Mineral wool.

Mineral deposit. Any valuable mass of ore. Like ore deposit, it may be used with reference to any mode of occurrence of ore, whether having the characters of a true, segregated, or gash vein, or any other form. *See* Ore deposit. (Century)

Mineral dresser. A machine for trimming or dressing mineralogical specimens. (Standard)

Mineral field (Scot.). A tract of country in which workable minerals are found; a mineral leasehold. (Barrowman)

Mineralization. 1. The process of replacing the organic constituents of a body by inorganic fossilization. 2. The addition of inorganic substances to a body. (Standard)
3. The act or process of mineralizing. *See* Mineralize (Webster). The process of converting or being converted into a mineral, as a metal into an oxide, sulphide, etc.

Mineralize. 1. To change from a metal into a mineral; as, iron when exposed to the air is *mineralized* into rust. (Standard)
2. To petrify. 3. To impregnate or supply with minerals. 4. To promote the formation of minerals, as heat is a mineralizing agent. 5. To go on an excursion for observing and collecting minerals. (Webster)

Mineralized matter. Crushed and loose rock material containing minerals irregularly deposited, from solution. It may be in beds, or in fissues. (Eureka Consol. Mining Co. *v.* Richmond Mining Co., 4 Sawyer, 312; Doe *v.* Waterloo Mining Co., 54 Fed. Rept., p. 943)

Mineralized zone. A mineral-bearing belt or area extending across or through a district. It is usually distinguished from a vein or lode as being wide, the mineralization extending in some cases hundreds of feet from a fissure of contact plane. *Compare* Contact deposit. *See* Zone, 2.

Mineralizers. The dissolved vapors in an igneous magma, such as steam, hydrofluoric acid, boracic acid, and others, that exert a powerful influence in the development of some minerals and textures. The word is also technically used in some definitions of ore. Thus it is said that an ore is a compound of a metal and a mineralizer, such as copper and sulphur, iron and oxygen, etc. (Kemp)

Mineral jelly. Vaseline. (Webster)

Mineral kingdom. One of the prime divisions of nature, embracing all minerals. (Standard)

Mineral lake. Tin-chromate glass, forming a pink pigment. (Standard)

Mineral land. Land more valuable for its deposits of stone, or whatever is recognized as mineral, than for agriculture. (McGlenn *v.* Wienbrocer, 15 Land Decisions, p. 375; Berry *v.* Central Pacific R. R. Co., 15 Land Decisions, p. 464; United States *v.* Iron Silver Min. Co., 128 United States, p. 673)

Mineral line. A railroad that carries only mineral. (Webster)

Mineral monument. A permanent monument established in a mining district to provide for an accurate description of mining claims and their location. (U. S. Min. Stat., pp. 227–231)

Mineralogist. One who is versed in the science of minerals, or one who treats or discourses of the properties of mineral bodies. (Century)

Mineralogize. To study and collect minerals, usually by outdoor practice. (Standard)

Mineralography. The study of the structure of minerals by the application of metallographic methods to polished sections of minerals. The microscope and reflected light thus bring out structures which could not otherwise be determined. (Eng. and Min. Jour., vol. 105, p. 934)

Mineralogy. That science which treats of those inorganic species called minerals, which together in rock masses, or in isolated form, make up the material of the crust of the earth. (Dana)

Mineral oil; naphtha. A limpid or yellowish liquid, lighter than water, and consisting of hydrocarbons. Petroleum is heavier than naphtha, and dark greenish in color when crude. Both exude from the rocks; but naphtha can be distilled from petroleum (Raymond). *See also* Petroleum.

Mineral paint. Minerals used as pigment, including the ochers, iron oxides, barite, etc. *See also* Ocher; Sienna; Umber. (U. S. Geol. Surv.)

Mineral pitch. Asphaltum.

Mineral purple. An iron-oxide red pigment. (Standard)

Mineral resin. Any one of certain mineral hydrocarbons, as asphalt and bitumen. (Standard)

Mineral right. The ownership of the minerals under a given surface, with the right to enter thereon, mine, and remove them. It may be separated from the surface ownership, but, if not so separated by distinct conveyance, the latter includes it. (Raymond)

Mineral seal oil. A trade term for an oil of the gravity 38.5° to 39° Bé., adapted for lighthouse and locomotive lights. It has a fire test of 300° F., a flash point of 255° F., and a viscosity of 45 to 50 at 100° F. on the Saybolt universal instrument. (Bacon)

Mineral sperm oil. *See* Mineral seal oil.

Minerals separation process. A flotation process based on surface-tension phenomena, accelerated by means of addition to the pulp of small quantities of oil and air in minute subdivision. There is only about 0.1 per cent oil added, and the pulp violently agitated for from 1 to 10 minutes. Innumerable small bubbles of air are thus mechanically introduced, which join the oil-coated particles. These are then removed in a spitzkasten. Exposure to the air after this treatment then aerates any mineral which has not already taken up its oil film, after which a second spitzkasten treatment removes this. (Liddell)

Mineral surveyor. *See* Deputy surveyor.

Mineral synthesis. The production of artificial minerals by a laboratory process.

Mineral tallow. Hatchettite. (Standard)

Mineral tar. 1. A viscid variety of petroleum. (Power)
2. Tar derived from various bituminous minerals, as coal, shale, peat, etc. Shale tar. (Standard)

Mineral time (Eng.). An eight-hour period in Derbyshire and in some other districts. (Hunt)

Mineral turpentine. *See* Turpentine substitutes.

Mineral vein. A vein formed by aqueous deposition, or by sublimation. A vein containing ore (Webster). *See also* Fissure; Lode; Vein.

Mineral water. A natural water coming from a spring and containing some characteristic mineral ingredient, as carbon dioxide or a lithium salt. (Standard)

Mineral wax. *See* Ozocerite.

Mineral way (Derb.). The roadway over which the miner transports ore to the highway, or supplies from the highway to the mine. (Mander)

Mineral white. Permanent white. Gypsum ground and used as a pigment. (Webster)

Mineral wool. A substance outwardly resembling wool, presenting a mass of fine interlaced filaments, made by subjecting furnace slag (or certain rocks) while molten to a strong blast. Being both insect-proof and fire-proof, it forms a desirable packing for walls, a covering for steam boilers, etc. (Standard). *Compare* Glass wool. Called also Mineral cotton; Silicate cotton; Slag wool.

Mineral yellow. A yellow pigment consisting of an oxychloride of lead; patent yellow. (Webster)

Minerar (Port.). To mine. (Halse)

Mine rent. The rent or royalty paid to the owner of a mineral right by the operator of the mine—usually dependent, above a fixed minimum, upon the quantity of product. (Raymond)

Mine rescue-apparatus. A name applied to certain types of apparatus worn by men, and permitting them to do work in noxious or irrespirable atmospheres such as obtain during mine fires, following mine explosions, as a result of accidents in ammonia plants, from smelter fumes, etc. Oxygen compressed in cylinders, a regenerating substance to purify the breathed air, with a closed circulation system constitute the general principle of the apparatus.

Mine rescue-car. One of a number of railway cars specially equipped with mine rescue-apparatus, safety lamps, first-aid supplies, and other materials, maintained by the U. S. Bureau of Mines in various sections of the United States. These cars serve: as movable stations for the training of miners in the use of mine rescue-apparatus, and in first-aid to the injured; as centers for the promotion of mine safety; as emergency stations for assisting at mine fires, explosions, or other disasters. Similar cars are maintained by a number of mining companies.

Mine rescue-crew. A crew consisting usually of five men who are thoroughly trained in the use of mine rescue-apparatus, and are capable of wearing it in rescue or recovery work in a mine following an explosion, or to combat a mine fire.

Mine rescue-lamp. A name given to a particular type of electric safety hand-lamp used in rescue operations. It is equipped with a lens for concentrating or diffusing the light beam as occasion may require.

Mineria (Sp.). Mining. This term embraces the whole subject, including both mines and miners, and also the operations of working mines and of reducing their ores. It, however, is often used in a more restricted sense. (Raymond)

Mineria, diputación de (Sp.). A tribunal cognizant of mining matters, elected in most cases by the mine owners of the district. (Min. Jour.)

Minerio (Port.). Ore. (Halse)

Minero (Sp.). Miner. This term is not limited to those who work mines, but includes their owners, and all who have the qualifications prescribed in the ordinances, and are enrolled as members of the body or craft. Many of the laborers who work in mines are not, technically speaking, miners. This term is sometimes used in the old laws for mine. (Raymond)

Mine road. Any mine track used for general haulage. (Chance)

Mine rock. A more or less altered rock found in ore channels (Power). Gangue.

Mine royal (Derb.). A gold or silver mine that belongs to the king, by his prerogative to make (coin) money. (Mander)

Miners' anemia. *See* Ankylostomiasis.

Miners' Asthma. *See* Pneumonoconiosis.

Miners' bar. An iron bar pointed at one end, chisel-edged at the other, used in coal mining. (Standard)

Miners' box. A wood or iron box located in or near the working place of the miner in which he keeps his tools, supplies, etc. Required by law in some States.

Miners' coal-ton. In Wales, 21 cwts. of 120 pounds each. (Gresley)

Miners' dial. An instrument used in surveying underground workings. (C. and M. M. P.)

Miners' elbow. A swelling on the back of the elbow due to inflammation of the bursa over the olecranon, so called because often seen in miners. (Webster)

Miners' friend. (Canterbury) The Davy safety lamp. (Webster)

Miners' hammer. A hammer for breaking ore. (Standard)

Miners' inch. The miner's inch of water does not represent a fixed and definite quantity, being measured generally by the arbitrary standard of the various ditch companies. Generally, however, it is accepted to mean the quantity of water that will escape from an aperture one inch square through a two-inch plank, with a steady flow of water standing six inches above the top of the escape aperture, the quantity so discharged amounting to 2274 cubic feet in twenty-four hours (Hanks). Inasmuch as the miner's inch is a local term "The flow of the water shall be expressed in cubic feet per second, and where it is desirable, for local reasons, to use the term 'miner's inch' it shall represent a flow of 1½ cubic feet per minute." (W. H. Shockley, Bull. 92, Min. and Met. Soc. of Am., Jan. 1916, p. 32). *Compare* Sluice head.

Miners' lamp. Any one of a variety of lamps used by a miner to furnish light; as, oil lamps, carbide lamps, flame safety lamps, electric cap-lamps, etc.

Miners' lung, Miners' asthma. *See* Pneumonoconiosis.

Miners' needle. A long, slender, tapering, metal rod left in a hole when tamping and afterwards withdrawn, to provide a passage, to the blasting charge, for the squib.

Miners' nystagmus. Nystagmus occurring among miners due to strain on the eyes from working by insufficient light. This subject is discussed in detail in Bull. 93, U. S. Bur. Mines, by F. L. Hoffman.

Miners' oil. An oil, producing little smoke, used in miner's wick-fed open lamps.

Miners' phthisis. *See* Anthracosis.

Miners' right. 1. An annual permit from the Government to occupy and work mineral land. C. and M. M. P) 2. In California, the right of a miner to dig for precious metals on public lands occupied by another for agricultural purposes; in Australia, a written or printed license to dig for gold. (Standard)

Miners' rules. Rules and regulations proclaimed by the miners of any district relating to the location, recording and the work necessary to hold possession of a mining claim. It was the miners' rules of the early days of the mining industry that were the basis of the present laws. (U. S. Min. Stat., pp. 192–195). The local mining laws and regulations of 1849 and later are given in Vol. 14, 10th Census of the United States, 1880, compiled by Clarence King.

Miners' sunshine. A soft grade of paraffin wax used by miners for burning in lamps. *See* Sunshine.

Miners' wax. A refined paraffin wax with a melting point of 118° to 120° F. (Bacon). *Compare* Sunshine.

Miners' wedge. A metallic wedge or plug for splitting off masses of coal. (Standard)

Miners' weight (Penn.). A term used in an old coal mining lease as the basis for a price per ton to be paid for mining. It is variable, but consists of such quantity of mine-run material as operator and miner may agree upon as necessary or sufficient to produce one ton of prepared coal. (Drake *v.* Berry, 102 Atlantic, p. 320)

Miners' worm. The hookworm, *agchylostoma duodenale*, which often infests miners and tunnel workers (Webster). *See* Ankylostomiasis.

Mine run. The entire unscreened output of a mine (C. and M. M. P.). Also called Run of mine.

Minery. Mines collectively; a mining district or its belongings; a quarry. (Century)

Mine safety-car. Same as Mine rescue-car.

Mine salting. *See* Salt, 3.

Mineta. 1. (Peru) Small mine-chamber or cavity. (Dwight)
2. Rock composed chiefly of feldspar and biotite mica, sometimes with chlorite, quartz, and hornblende. A mica syenite. (Halse)

Mine tin. Tin obtained from veins or lodes, as distinguished from stream tin. (Ure)

Minette. A variety of mica-syenite, usually dark and fine grained, occurring in dikes. (Kemp)

Mine work. (Eng.) An ironstone mine or workings. (Gresley)

Minge; Mingy coal. Coal of a tender or friable nature. (Gresley)

Mingles (Scot.). The vertical timbers of the upper part of a pulley frame, on the top of which the pulleys are fixed (Gresley). *See* Maidens.

Mining. 1. Act or business of making mines or working them (Webster). The processes by which useful minerals are obtained from the earth's crust, including not only underground excavations but also open workings; it also includes both underground and surface deposits. (Burdick *v.* Dillon, 144 Fed. Rept., p. 739)
2. (Ark.) The excavation made in undermining a coal face. 3. (Ark.) A soft band of dirt in, or beneath, a coal seam in which a preliminary excavation can be readily made. (Steel). *See also* Mining ply.
4. Reduction of ore, whether mined or purchased, and refining the products thereof, is mining, within the statute permitting the cutting of timber for mining purposes. (United States *v.* Richmond Mining Co., 40 Fed. Rept., 415)

Mining advancing. A method of mining by which the ore or coal is mined as the excavation advances from the shaft or main opening. *Compare* Mining retreating.

Mining camp. 1. A colony of miners settled temporarily near a mine. (Standard)
2. A term loosely applied to any mining town.

Mining case. A frame of a shaft, or gallery, composed of four pieces of plank. (Standard)

Mining claim. 1. That portion of the public mineral lands which a miner, for mining purposes, takes and holds in accordance with mining laws. (Escott *v.* Crescent Coal & Navigation Co., 56 Oregon, p. 192; 106 Pacific, 452; Mt. Diablo M. & M. Co. *v.* Callison, 4 Sawyer, p. 439; Morse *v.* De Ardo, 106 California, p. 622; Salisbury *v.* Lane, 7 Idaho, p. 370; Bewick *v.* Muir, 83 California, p. 363; Berentz *v.* Beltmont Oil Co. 148 California, p. 577; Black *v.* Elkhorn Mining Co., 49 Fed. Rept. 549, p. 553)
2. A mining claim is a parcel of land containing precious metal in the soil or rock. A *location* is the act of appropriating such parcel of land according to law or to certain established rules (Smelting Co. *v.* Kemp 104, United States, p. 649; Peabody Gold Mining Co. *v.* Gold Hill Mining Co. 97 Fed. Rept. p. 661; McFeters *v.* Pierson, 15 Colorado, p. 203; 24 Pacific, 1076, 1890). *See* Claim; Lode mining claim; Placer claim; Location, 3. (U. S. Min. Stat., p. 51)

Mining débris. The tailings from hydraulic mines. Also called Débris. (Century)

Mining district. A settlement of miners organized after the plan that, in the first years of mining in the Western part of the United States, the miners, in the independence of all other authority, devised for their own self-government (Century). A section of country usually designated by name and described or understood as being confined within certain natural boundaries, in which gold or silver (or other minerals) may be found in paying quantities. (United States *v.* Smith, 11 Fed. Rept., p. 490)

Mining easement. *See* Easement.

Mining engine. 1. *See* Man machine.
2. Any engine used in mining, as a pump engine or mine locomotive. (Standard)

Mining engineer. One versed in, or one who follows, as a calling or profession, the business of mining engineering. Graduates of technical mining schools are given the degree of 'engineer of mines' and authority to sign the letters E. M., after their names. The letters 'M. E.' stand for mechanical engineer, when given by a school, but are often used by men engaged in mining, who lack scholastic degrees, as an abbreviation for mining engineer, or mining expert.

Mining engineering. That branch of engineering dealing with the excavation and working of mines. (Webster) It includes much of civil, mechanical, electrical, and metallurgical engineering.

Mining geology. *See* Geology.

Mining machine. A coal-cutting machine. (Standard)

Mining ore from top down. *See* Top-slicing and cover-caving.

Mining partnership. 1. A partnership in mining business in which one partner may sell his partnership interest, and bring his purchaser into the partnership without making a dissolution. (Standard)
2. Under the Civil Code of California (Section 2511), a mining partnership exists when two or more persons acquire a mining claim and actually engage in working the same. The actual working of the mine by the joint owners is essential to a mining partnership. (Peterson *v.* Beggs, 148 Pacific, p. 542)

Mining ply. A soft, thin, interstratified portion of a coal bed. In the Pittsburgh seam of western Maryland it is 3 to 6 inches thick, and it is in this that the machine does the undercutting. (Md. Geol. Surv., vol. 5, p. 540). *See* Mining, 5.

Mining retreating. A process of mining by which the ore, or coal, is untouched until after all the gangways, etc., are driven, when the work of extraction begins at the boundary and progresses toward the shaft. (Steel)

Mining under. The act of digging under coal or in a soft strata in coal seams. (Daddow)

Minio (Sp.). Red lead. (Min. Jour.)

Minion. The siftings of iron ore after calcination. (Standard)

Ministerio (Sp.). Ministry; *M. de hacienda*, Ministry of the Exchequer or Treasury; *M. de fomento*, Ministry of Public Works and Instruction. In Spanish America, the Ministry of Encouragement and Promotion. (Halse)

Minium. Red oxide of lead, $2PbO.PbO_2$ Contains 90.6 per cent lead. (U. S Geol. Surv.)

Miñón (Sp.). 1. An iron slag. 2. An earthy iron ore. (Halse)

Minophyric. Minutely porphyritic rocks with phenocrysts whose longest diameters are between 1 mm. and 0.2 mm. *See* Magnophyric and Mediophyric. (Iddings, Igneous Rocks, p. 200)

Minseed oil. A bloomless petroleum product, used in connection with linseed oil for cheapening purposes. *See* Paint oil. (Bacon)

Minus sight. *See* Foresight, 1.

Miny. Pertaining to, or like a mine. (Webster)

Miocene. The third of the four epochs into which the Tertiary period is divided. Also the series of strata deposited during that epoch. (La Forge)

Mirabilite; Glauber's salt. Hydrous sodium sulphate, $Na_2SO_4+10H_2O$. (U. S. Geol. Surv.)

Mirror black. Having a lustrous black gloss; said of pottery. (Standard)

Mirror plate. Plate glass suitable for mirrors. (Standard)

Mirror Stone. Muscovite.

Mischio marble. A violet-red breccia from Serravezza, in Italy; also known as African breccia (*Breche africaine*). (Merrill)

Misenite. Probably acid-potassium sulphate, $HKSO_4$. In silky fibers of a white color. (Dana)

Miser. A tubular well-boring bit having a valve at the bottom, and a screw for forcing the earth upward (Standard). Also spelled Mizer.

Misfire. The failure of a blasting charge to explode when expected. In electric firing, usually due to broken circuit or insufficient current. If the electric blasting-cap fires without exploding the charge, it is usually due to misplaced detonator or the charge has been affected by storage in a wet place. Misfires with fuse and blasting-caps are generally due to the fuse going out or to the failure of the fuse to ignite the blasting-cap. Failure of the blasting-cap to detonate the dynamite, when it is fired, is usually due to its having been affected by dampness. (Du Pont)

Misfire hole; Missed hole. A drill hole containing an explosive charge that has failed to explode. (Peterson *v.* Otho Development & Power Co. 166 N. W. Rept., p. 147)

Mispickel. A sulpharsenide of iron, FeS_2FeAs_2 (Dana). Arsenopyrite.

Mission tile. A name sometimes applied to roofing tile of semicircular cross section. (Ries)

Mississippian. The first of the three epochs into which the Carboniferous period is ordinarily divided; regarded by many geologists as itself a peroid. Also the series of strata during that epoch. (La Forge)

Missourite. A granular igneous rock consisting of leucite, biotite, augite, olivine, iron ores and apatite, and corresponding to the effusive leucite-basalts. It was discovered in the Highwood Mountains, Mont., by Weed and Pirsson, and named by them from the Missouri River, the most prominent and best known geographical object in the region. (Kemp)

Mistress. 1. (Scot.) A water-proof cover for miners when sinking in a wet shaft. (Barrowman)
2. (No. of Eng.) A wooden or tin box, having the front open, in which a candle is carried in a pit. (Gresley)

Misy (Egypt). A synonym for Copiapite.

Mita. 1. (South America) Under Spanish rule, 1548 to 1729, compulsory mining work done by Indians. The Indians were drawn by lot one in seven being taken for work in the mines. 2. (Peru) Tribute paid by Indians. (Halse)

Mitayo. 1. (Sp. Am.) Under the Spanish rule, 1548 to 1729, an Indian chosen by lot to serve his term of compulsory labor in mines. 2. (Peru) An Indian who collects tribute. (Halse)

Mitchell slicing system. *See* Sublevel stoping.

Miter cut. In glass making, an angular groove, as in plate glass, having a bottom angle of approximately 90°. (Standard)

Mitered tile. Roofing tile cut off obliquely, so as to fit in upright work, such as dormer corners. It also includes pieces flanged at right angles so as to cover such corners. (Ries)

Miter iron. A fagot of round iron bars arranged about a central circular bar, ready for forging. (Standad)

Mitis casting. 1. The process of making castings of wrought iron, the melting point of which has been lowered by a slight addition of aluminum. 2. A casting made by this process. (Standard)

Miuçalheiros (Braz.). Trammers, shovelers, and helpers. (Halse)

Mixta (Mex.). Alloy of gold and silver. (Dwight)

Mixture. A commingling in which the ingredients retain their individual properties or separate chemical nature: if chemically combined it is a *compound*. *See* Mechanical mixture. (Standard)

Mizer. The chief tool used in certain systems of sinking the cylinders of small shafts through water-bearing strata, to remove the ground from beneath them (Gresley). *See* Miser.

Moat. 1. A ditch or deep trench. To surround with a ditch. (Century) 2. (Scot.) To puddle; to cover up the mouth of a pit or other opening so as to exclude air in the event of an underground fire. (Barrowman)

Moating. Clay backing for a masonry shaft sunk through quicksand. (Webster)

Mobby (So. Staff.). A leathern girdle, with a small chain attached, used by the boys who draw bowks (buckets or tubs). (Raymond)

Mocha pebble. Same as Moss agate. Called also Mocha stone. (Standard)

Mocha stone. A white variety of quartz banded with various colors, and used as gem (Standard). *See* Moss agate.

Mock lead. A Cornish term for zinc blende; also called Wild lead. (Davies)

Mock ore. Same as Sphalerite. (Standard)

Mock platinum. An alloy of 8 parts of common brass and 5 of zinc. (Standard)

Mock silver. A white alloy of copper, tin, nickel, zinc, etc., of the same class as Britannia metal; pewter. (Standard)

Mock vermilion. A basic chromate of lead. (Webster)

Moco. 1. (Sp.) Scoria of iron. 2. *M. de hierro* (Venez.), brown iron ore; a highly ferruginous rock. (Halse)

Mode. The actual mineral composition of an unaltered igneous rock: contrasted with Norm, *which see*. (La Forge)

Modeling clay. Fine, plastic clay, especially prepared for artists in modeling by kneading with glycerin, or by other methods. (Century)

Modified room-and-pillar working. *See* Bord-and-pillar method.

Modulus of elasticity. A number determining the extension or change of form (strain) of a body under the influence of a stretching or distorting force (stress), and, in the case of a body whose dimensions are all unity, equal to the ratio of the strain to the stress. (Standard)

Modulus of rupture. The measure of the force which must be applied longitudinally in order to produce rupture. (Webster)

Moebius process. A method of electrolytic refining of silver. Silver plate of 95 to 98 per cent pure forms the anodes, and thin silver plate forms the cathodes. The electrolyte consists of a weak acidulated solution of silver nitrate. (Goesel)

Mofeta (Sp.). Gas found in mines; afterdamp. (Halse)

Mofette. An emanation from the earth of noxious gas, chiefly carbon dioxide, marking the last stage of volcanic activity; also, the opening from which the gas issues. *See also* Fumarole, Solfatarra, and Soffioni. (Webster)

Mogrollo (Mex.). Silver ores, composed of sulphides. (Halse)

Mohr's salt. Ferrous-ammonium sulphate, $Fe(NH_4)_2(SO_4)_2.6H_2O$. A light green crystalline salt. (Webster)

Mohsite. Native titanic iron; ilmenite. (Century)

Moil. 1. A short length of steel rod tapered to a point, used for cutting hitches, etc. (Ihlseng) 2. A long gad used for accurate cutting in a mine; a set. 3. In glass

blowing, metallic oxide adhering to glass when it is detached from the end of the blowpipe. (Standard)

Moiré métallique (Fr.). Tin-plate, or iron plate that has been first coated with tin, so treated by acids as to give it a clouded, variegated or variously crystallized surface. (Century)

Moissan process. A process for the reduction of chromic oxide with carbon in an electric furnace, the hearth of which is lined with a calcium chromite prepared by heating together lime and chromic oxide. (Goesel)

Mojón; Mojonera (Mex.). Stone pillar to mark corner of a claim. Any boundary mark. (Dwight)

Mojona (Sp.). A survey of land; the placing of landmarks. (Halse)

Mold; Mould. 1. An impression made in the earth by the outside of a fossil shell, or other organic form; sometimes misused for cast. 2. The matrix or cavity in which anything is shaped and from which it takes its form; also the body or mass containing the cavity, as a sand mold for casting metal. (Webster) 3. The form into which fused metal is run to obtain a cast. 4. The plaster forms used in making terra-cotta architectural ornaments. (Century)

Moldavite; Moldauite. A transparent, green, vitreous stone or natural glass, regarded by some petrologists as of meteoric origin and by others as a form of obsidian. (La Forge) *See also* Bouteillenstein.

Mold board. A board on which to ram a pattern; a follow board. (Standard)

Mold box. A box in which molten steel is hydraulically compressed. (Standard)

Molde (Mex.). Mold. (Dwight)

Molded brick. A term sometimes used for soft-mud brick. (Ries)

Molded coal. An artificial fuel made of charcoal refuse and coal tar, molded into cylinders, dried, and carbonized. (Century)

Molder; Moulder. 1. One who makes molds for castings. 2. One who molds tempered clay into unburned bricks. (Standard)

Mold facing. A fine powder or wash applied to the face of a mold to insure a smooth casting. (Standard)

Molding crane. A crane adapted for use in a foundry in handling molds and flasks. (Century)

Molding frame. A template to shape a loam mold. (Standard)

Molding hole. An excavation in a foundry floor for large castings. (Standard)

Molding loam. A mixture of clay and sand employed by founders in constructing molds. (Century)

Molding machine. A machine for making (*a*) loam molds in flasks, from small complete patterns, or (*b*) gear-wheels and other large symmetrical objects by a radial frame bearing a template, or pattern of a small section of the gear; a gear-molding machine. (Standard)

Molding sand. A mixture of sand and loam used by founders in making sand molds. (Standard)

Molding table. Potter's table for shaping their ware. (Standard)

Mole (Colom.). 1. Galena. 2. Sulphides or concentrates consisting principally of galena. (Halse)

Molecule. The smallest part of a substance that can exist separately and still retain its composition and characteristic properties; the smallest combination of atoms that will form a given chemical compound. (Rickard)

Moledor (Peru). A man in charge of grinding operations. (Halse)

Moledora (Peru). Upper millstone. (Dwight)

Moler (Sp.). To grind or crush ore; *M. en seco* (Peru), dry grinding; *M. por sutil* (Peru), wet grinding. (Dwight)

Molienda. 1. (Mex.) Charge of ore to be ground and amalgamated (Dwight). 2. Grinding or crushing ores. (Halse)

Molinete. 1. (Colom.) A kind of windlass; a winch. 2. The beater used on a dolly tub. (Halse)

Molino. 1. (Mex.) An ore-grinding mill; *M. chileno*, Chilian mill; *M. de muestra*, sample grinder. (Dwight) 2. Ore sent to the mill. 3. (Colom.) A buddle. 4. Alluvial sands accumulated in the ground sluices. (Halse)

Molluskite. The dark-colored carbonaceous matter sometimes found in shell marbles due to the petrifaction of organic portions of mollusks. (Standard)

Molly Maguire. A member of a secret association of Irishmen organized in the Anthracite coal region of Pennsylvania about 1854, for the purpose of intimidating employees and officers of the law and for avenging themselves, by murder, on persons obnoxious to them. The society was broken up after the execution of a number of the members following serious and extensive rioting, in 1877. (Webster)

Molonque (Mex.). Rich specimen, of which one-half, or more, is silver. (Dwight)

Molten. Reduced to the fluid state by heat; melted; fused; as, *molten* metal. (Standard)

Molybdenite. Sulphide of molybdenum, MoS_2. Contains 60 per cent molybdenum. (U. S. Geol. Surv.)

Molybdenum. A metallic element of the chromium group, resembling iron in its white color, malleability, difficult fusibility and its capacity for forming steel-like alloys with carbon. Symbol, Mo; atomic weight, 96.0; specific gravity, 9.01. (Webster)

Molybdic ocher. Same as Molybdite.

Molybdite. Molybdenum trioxide, MoO_3, in capillary tufted forms and earthy. Color straw-yellow. (Dana)

Molybdocolic. Lead colic. (Century)

Molybdomancy. Divination by means of molten lead, the diviner basing his conclusions on the number, form, and motions of the drops that float on the surface. (Standard)

Molybdonosus. Lead poisoning. (Standard)

Molybdoparesis. Lead palsey; painters' paralysis. (Standard)

Molysite. An incrustation, brownish-red, light or dark, and yellow, ferric chloride, $FeCl_3$, found usually in the vicinity of volcanoes as a deposit on lavas, etc. (Dana)

Momme. A Japanese weight equal to 3.75 grams, or 2.4112 pennyweights. (Weed)

Monadnock. A residual rock, hill, or mountain standing above a peneplain. (La Forge)

Monazite. Phosphate of the cerium metals (cerium, didymium, lanthanum) and other rare-earth metals, including thorium, which alone gives it commercial value. Some varieties carry no thorium, but others carry as much as 18 per cent thorium oxide. (U. S. Geol. Surv.)

Monchiquite. An aphanitic or felsophyric igneous rock containing augite and barkevikite, with or without biotite, olivine, and analcite, in a groundmass of analcitic glass. (La Forge) The name was suggested by Rosenbusch from the Monchique Mountains of Portugal for basaltic dikes corresponding in mineralogy and texture to limburgite. They often accompany nephelite-syenite. In modification of the original view that the monchiquites have a glassy groundmass, L. V. Pirsson has urged with much reason, and with the additional evidence of chemical analysis, that the supposed glass is analcite. The presence of so much glass in so basic a rock is improbable. (Kemp)

Mondar (Sp.). To sort hand-picked ore. (Halse)

Mondeo (Braz.). 1. A large masonry reservoir for collecting gold-bearing sand. 2. A settling pit. (Halse)

Mond gas. A variety of semiwater gas, having typically a calorific value of about 145 B. t. u. per cubic foot. Ammonia is often collected as a by-product. (Webster)

Mondhaldeite. A name derived from a locality on the Kaiserstuhl, Baden, and applied by A. Osann to a group of dike rocks having the mineralogy of the hornblende-pyroxene andesites. Chemically they are andesites of about 60 per cent in silica, and with almost as much potash as soda. (Kemp)

Mond producer. A furnace used for the manufacture of producer gas. (Ingalls)

Monel Metal. A whitish alloy of high tensile strength and elastic limit, consisting of nickel 75 per cent, copper 23.5 per cent, and iron 1.5 per cent. (Webster)

Monheimite. A variety of smithsonite containing iron carbonate. (Dana)

Monitor. 1. In hydraulic mining, a contrivance consisting of nozzle and holder, whereby the direction of a stream can be readily changed. (Standard)

2. A car used to lower (or raise) coal on an incline. *See also* Gunboat. (Steel)

Monkey. 1. (Scot.) An appliance for mechanically gripping or letting go the rope in rope haulage. (Barrowman)
2. A contrivance placed between the rails at the head of an incline to prevent wagons or cars from running back. (Webster)
3. A small water-cooled bronze casting in the cinder-notch cooler through which cinder runs from cinder-notch when the bot is withdrawn. (Willcox)
4. A small glass-melting crucible. (Standard)
NOTE: The word "monkey" prefixed to a technical term means *small*, thus, *monkey* chute, a small chute; *monkey* drift, a small drift—usually driven in for prospecting purposes. (Chance)

Monkey boss. A man in charge of flushing the furnace and of claying up monkey and coolers. Helps on tapping hole also, and at cast. *See also* Monkey, 3. (Willcox)

Monkey chock (Aust.). *See* Bobbin, 1.

Monkey drift. A small drift driven in for prospecting purposes, or a crosscut driven to an airway above the gangway. (C. and M. M. P.)

Monkey gangway (Penn.). An air course driven parallel with a gangway and heading at a higher level (Gresley). Used where a seam has considerable pitch or dip.

Monkey jar. An earthenware vessel used in tropical countries for cooling drinking water. Also called Water-monkey (Standard). In Mexico it is called an *Olla*.

Monkey rolls. The smaller rolls in an anthracite breaker. (C. and M. M. P.)

Monkey shaft. A small shaft raise extending from a lower to a higher level. (C. and M. M. P.)

Monnier process. The treatment of copper sulphide ores by roasting with sodium sulphate, and subsequent lixiviation and precipitation. (Raymond)

Mono (Mex.). Vertical stull. (Dwight)

Monobasic. In chemistry, noting an acid which contains but one atom of hydrogen replaceable by a univalent element or radical to form a neutral salt. (Century)

Monoclinal. 1. Dipping only in one direction, or composed of strata so dipping; as, a *monoclinal* ridge; a *monoclinal* flexure. Sometimes improperly called *uniclinal*. 2. An abrupt downward flexure of nearly horizontal strata without any corresponding bend to form an anticline or syncline. 3. Loosely, any series of strata dipping in one direction only, as an isocline. (Standard)

Monocline. A monoclinal fold (Webster). *See* Monoclinal.

Monoclinic system. That system of crystals whose forms are referred to three unequal axes, two intersecting obliquely and the third perpendicular to both the others. (La Forge)

Monoclinic block. A quarry term, applied to a block of stone bounded by three pairs of parallel faces, eight of the twelve interfacial angles being right angles, two obtuse angles, two acut angles. (Bowles)

Monogenetic. One in genesis; resulting from one process of formation; said of a mountain range. (Webster)

Monolith. 1. A single stone or block of stone, especially one of large size, shaped into a pillar, statue, or monument. 2. A building material for floors, having a sawdust base and applied in a plastic condition. It is both fireproof and waterproof. (Webster)

Monometallic. Consisting of but one metal; specifically, comprising coins that consist of but one metal (or alloy), as gold or silver. (Century)

Monsel's salt. A basic sulphate of iron. (Webster)

Montaña. 1. (Sp.) Mountain. 2. (Mex.) Ores scattered through country rock and not found in deposits of any appreciable size. (Halse)

Montanite. A rare tellurate of bismuth, $Bi_2O_3.TeO_3.2H_2O$, from Montana. (Dana)

Montar. 1. (Sp.) To erect machinery or a plant. 2. (Colom.) To construct ditches for mining purposes. (Halse)

Monte-acid (Fr.). An acid elevator, as an apparatus by which acid is forced by compressed air to the top of one of the towers of a sulphuric acid manufactory. (Webster)

Monteador (Colom.). A prospector who searches for mines in forests and mountains. (Halse)

Montefiore furnace. A small furnace used for the recovery of zinc from blue powder by liquation. (Ingalls, p. 527)

Montejus (Fr.). An apparatus for raising a liquid by pressure of air, or steam, in a reservoir containing the liquid, utilizing the principle of the wash bottle of the chemical laboratory.

Monticellite. A calcium-magnesium silicate, $CaMgSiO_4$. In colorless to gray crystals, in masses (batrachite), or in crystals or grains in limestone. (Dana)

Monticle. A little hill, knob, or mound; especially, a subordinate volcanic cone. (Standard)

Monticulate. Characterized by or having little knobs or hills. (Standard)

Montiform. Mountain-like; having the shape of a mountain. (Century)

Montmartrite. A variety of gypsum, containing calcium carbonate. (Standard)

Montón (Sp.). 1. An ore heap. 2. A quantity of ore undergoing amalgamation. 3. A Mexican unit of weight for ore, varying from 1,800 to 3,200 Spanish pounds, according to locality. (Standard) 4. (Colom.) An irregular mass or deposit. 5. *M. recto*, a wide vein between a stratified and nonstratified formation (Halse). A contact vein.

Monton wax. A wax obtained from bitumen extracted from Thuringian lignite by treatment with superheated steam, used principally as a carnauba-wax (Brazilian palm wax) substitute in the manufacture of polishes and as an insulating material in place of ceresin. (Bacon)

Montre (Fr.). In ceramics, an opening in a kiln-wall to permit inspection of the contents. (Standard)

Montroydite. Oxide of mercury, HgO. (U. S. Geol. Surv.)

Monument. A stone or other permanent object serving to indicate a limit, or to mark a boundary, as of a mining claim.

Monumentos (Mex.). Land marks or monuments; for mining claims, usually built of masonry, and placed at each corner of a mining claim. (Halse)

Monzonite. A granular igneous rock composed essentially of alkali-calcic plagioclase and orthoclase in nearly equal amounts, and accessory hornblende, biotite, or augite; nearly the same as Vogoite, *which see* (La Forge). Brögger recently used the name for a transitional and intermediate group of granitoid rocks between the granite-syenite series and the diorites. (Kemp)

Moonstone. A variety of feldspar, commonly transparent or translucent orthoclase, albite, or labradorite, which exhibits a delicate pearly opalescent play of colors. (U. S. Geol. Surv.) Used as a gem.

Moor. 1. A more or less elevated tract of open, waste, or barren land, having, as a rule, a rather broad, flat, and poorly drained surface, commonly diversified by peat-bogs and patches of heath. (La Forge) 2. (Corn.) An enrichment of ore in a particular part of a lode (Davies). *See also* More.

Moorband. A synonym for Moorpan, and Moorband pan.

Moorband pan; Moorpan (Eng). A hard ferruginous crust that forms at the bottom of boggy places above a stiff and impervious subsoil. (Power)

Moor coal. A friable variety of lignite. (Century)

Moore filter press. A movable, intermittent vacuum filter consisting of a series, or basket, of leaves fastened together in such a way that it may be dropped in a pulp tank and kept submerged until a cake is formed. It is then transferred by crane to an adjoining wash-solution tank and washed. The basket is then lifted out of the tank and the cake dropped. (Liddell)

Moorhouse (Corn.). A hovel built of turf for miners to change clothes in. *See* Changehouse.

Moorpeat. Peat formed from moss, and such as is found in certain moors. (Standard)

Moorstone (Corn.). Loose masses of granite found on Cornish moors. (Raymond)

Moor whin. Same as Whin.

Mop. A disk surrounding a drill to prevent water from splashing up. (C. and M. M. P.) Also, a piece of burlap or coarse cloth used for the same purpose.

Morainal apron. Same as Apron, 8.

Moraine. An accumulation of earth, stones, etc., carried and finally deposited by a glacier. A moraine formed at the extremity of a glacier is called a *terminal moraine;* at the side, a *lateral moraine;* in the center and parallel with its sides, a *medial moraine* and beneath the ice but back from its end or edge, a *ground moraine.* (Webster)

Moraine profonde. Same as Ground moraine. *See* Moraine.

Morainic. Of, pertaining to, forming, or formed by a moraine. (Standard)

Morainic loops. Great loops, convex southward, in the continental terminal moraine of the North American glacial period; caused by ice-tongues filling valleys. The junction of contiguous loops form the interlobular moraines. (Standard)

Morass ore. Same as Bog iron ore. (Standard)

More (Corn.). A quantity of ore in a particular part of a lode, as a more of tin (Raymond. *See also* Moor, 2.

Morenosite. A hydrated nickel sulphate, $NiSO_4+7H_2O$. (Dana)

Morgan (Aust.). A band of carbonaceous shale occurring in the Borhole seam. (Power)

Morgen (Dutch). A South African land measure equal to 1.44 claims, or 2.1165 English acres. (Skinner)

Morillos (Mex.). Round poles for light timbering. (Dwight)

Morion. A nearly black variety of smoky quartz. (Dana)

Morlop (Aust.). A mottled jasper-pebble found in New South Wales, and much sought by miners, as it usually occurs with diamonds. (Standard)

Moromoro (Peru). An impervious, argillaceous rock. (Halse)

Moroxite. A blue, or greenish-blue variety of apatite. (Dana)

Morro (Mex.). Furnace-wall accretions. (Dwight)

Mortar. 1. A heavy iron vessel, in which rock is crushed by hand with a pestle, for sampling or assaying. 2. The receptacle beneath the stamps in a stamp mill, in which the dies are placed, and into which the rock is fed to be crushed. (Raymond)
3. A building material made by mixing lime, cement, or plaster of Paris, with sand, water, and sometimes other material and used in masonry, plastering, etc. (Webster)

Mortar box. The large, deep, cast-iron box into which the stamps fall and the ore is fed in a gold or silver stamp-mill; also called Stamper-box (Roy. Com). *See* Mortar, 2.

Mortar mill. A mixing and stirring machine for combining lime, sand and other materials to make mortar. A form of pug mill. (Century)

Mortar structure. A term suggested by Törnebohm to describe those granites, gneisses or other rocks that have been dynamically crushed, so that large nuclei of their original minerals are set in crushed and comminuted borders of the same, like stones in a wall. (Kemp)

Mortero (Sp.). 1. A stamp-mill. 2. The mortar of a stamp. 3. *M. común,* ordinary mortar. (Halse)

Mortification. Destruction of active qualities, as in mercury amalgamation. (Standard)

Mortise. A hole cut in one piece of timber, etc. to receive the tenon that projects from another piece. (C. and M. M. P.)

Morts terrains (Fr.). Barren or dead ground. The water-bearing strata overlying the coal measures. (Gresley)

Mosaic gold. Disulphide of tin. (Raymond)

Mosaic silver. An amalgam of mercury, tin, and bismuth, used for imitating silverwork. (Standard)

Moscorrofio (Colom.). Gold in wire or filaments accompanying pebbles; angular, or but little rounded gold. (Halse)

Mosqueado (Mex.). Spotted. Dark ruby silver occurring in separate grains or spots in quartz or other matrix. (Halse)

Moss agate. A kind of agate containing brown or black moss-like dendritic forms, due to the oxides of manganese or iron distributed through the mass. (Century.) Also called Mocha pebble; Mocha stone.

Moss box. A cast-iron, annular, open-topped box or ring, placed in water-bearing ground for making a water-tight seat, or bed, for the tubbing in the Kind-Chaudron system of shaft sinking. (Gresley)

Moss fallows. Parts of a bog from which the moss has been removed for fuel. (Standard)

Moss gold. Gold in dendritic forms. (Webster)

Moss hag (Scot.). A place where peat has been cut or washed away, leaving a treacherous surface. (Webster)

Moss land. Land abounding in peat moss, but scarcely wet or marshy enough to be called a bog or morass. (Standard)

Moss silver. Silver in dendritic or filiform shapes. (Webster)

Mossy. Like moss in form or appearance. Said of certain minerals. (Dana)

Mostrador (Mex.). Sampler. (Dwight)

Mote; moat. A straw filled with gunpowder for igniting a shot (Gresley). A fuse.

Mothergate. 1. (No. of Eng.) A road in the workings to be eventually converted into a main road. (Gresley)
2. (Newc.) The main passage in a district of mine workings. (Raymond)

Mother lode. 1. The principal lode or vein passing through a district or particular section of country. (Hanks)
2. The 'Great quartz vein' in California, traced by its outcrop for 80 miles from Mariposa to Amador (Standard). *See* Champion lode; *also* Veta madre.

Mother of coal. *See* Mineral charcoal.

Motion. 1. (Ohio) A local term for the area of a quarry covered by the swing of a derrick boom, and, in addition, the area from which the blocks of stone may be economically dragged. (Bowles)
2. A term used in granite regions to designate small paving-block quarries. (Perkins)
3. A place in which a stonecutter quarries his own stone for subsequent cutting and finishing. 4. The part of the pit in which work is in actual progress. (Webster)

Motive column. The length of a column of air whose weight is equal to the difference in weight of like columns of air in downcast and upcast shafts. The ventilation pressure, in furnace ventilation, is measured by the difference of the weights of the air columns in two shafts. (Steel)

Motive power. Any power, as water, steam, wind, electricity, used to impart motion to machinery. (Webster)

Motor. 1. One who or that which produces or imparts motion or mechanical power. Specifically, a machine for producing or causing motion, especially one that acts by transmitting some other kind of energy into mechanical energy, or the energy of position into that of motion; a prime mover, as a steam engine, windmill, water wheel, or reversed dynamo. (Standard)
2. A haulage engine used around mines and operated by electricity or compressed air.

Motor body. The box-like portion at the lower end of a coal-cutting machine. (Morris *v.* O'Gara Coal Co., 181 Illinois App., p. 312)

Mottle. The spotted, blotched, or variegated appearance of any surface, as of wood or marble; especially, in metallurgy, the appearance of pig iron of a quality between white and gray. (Standard)

Motty (Eng.) A collier's mark on his corf (Webster). *See* Tally.

Moulin (Fr.). A nearly vertical shaft in a glacier into which a stream of water pours. (Webster)

Mountain. An eminence or ridge, either isolated or part of a range or of a group, standing conspicuously above the surrounding or neighboring country and, as a rule, characterized by steeply sloping sides, a relatively small summit area, and considerable bare rock surface. (La Forge)

Mountain blue. Blue copper ore; azurite. (Skinner)

Mountain brown ore. Limonite or brown iron ore. A local name applied in Virginia to the low-grade siliceous variety, which commonly occurs in hard lumps and which is found on the mountain slopes at or near the contact of the Cambrian shale and sandstone with the Cambro-Ordovician limestone. *See* Valley brown ore. (U. S. Geol. Surv.)

Mountain butter. A synonym for Alunogen (Chester). A hydrated aluminum sulphate in delicate fibrous masses or crusts.

Mountain chain. A series of mountains connected, and having some common characteristics.

Mountain cork. A variety of asbestos resembling cork. It is light and floats on water (Dana). Also called Mountain leather.

Mountain crystal. Rock crystal. (Webster)

Mountain flax. 1. Amianthus. A fine silky variety of asbestos. (Power) 2. Asbestos or asbestos-cloth. (Standard). Called also Earth flax.

Mountain green. Malachite. (Power)

Mountain leather. A tough variety of asbestos in thin, flexible sheets (Dana). *See also* Mountain cork.

Mountain limestone. The English designation of a limestone of the lower part of the Carboniferous age; called also Sub-Carboniferous limestone. (Raymond)

Mountain meal. Infusorial earth (Power). *See also* Bergmehl.

Mountain-milk. A very soft, spongy variety of calcite. (Standard)

Mountain paper. A thin, paper-like, variety of mountain cork. (Power)

Mountain range. 1. Loosely, same as Mountain chain. 2. Strictly, one of the component portions of a mountain chain, formed by a single orogenic movement (monogentic). (Standard)

Mountain soap. An unctuous variety of halloysite containing some iron oxide and about 24 per cent water. (Dana)

Mountain tallow. A soft, waxlike, hydrocarbon; also known as Hatchettite. (Dana)

Mountain wood. A variety of asbestos that is compact, fibrous, and gray to brown in color, looking like wood. (Dana)

Mounting pipe. *See* Column pipe.

Mouse-eaten quartz. Quartz full of holes once occupied by sulphides, now decomposed and gone. (Power)

Mousseline (Fr.). A thin glass, blown so as to imitate patterns in lace. as for claret-glasses. Called also Mousseline glass, Muslin glass. (Standard)

Mouth. 1. An opening resembling or likened to a mouth, as one affording an entrance or exit. 2. The opening in a metallurgical furnace through which it is charged; also the tap hole. 3. Any of several furnaces, each connected by a flue to a central opening in the oven of a pottery kiln. (Webster)
4. The end of a shaft, adit, drift, entry, tunnel, etc., emerging at the surface. (Raymond)

Mouthing (So. Staff.). A synonym for Inset.

Mouth of pit (Aust.). The top of a shaft. (Power)

Mouth plate. 1. (Scot.) A ridged cast-iron plate to direct hutch wheels from plates to rails. 2. (Scot.) An iron plate over the mouth of a bore hole. (Barrowman)

Movable ladder. *See* Man machine.

Movable stock (Eng.). Such equipment as can be sold without prejudice to the working of the colliery. It comprises, therefore, old pumps, unnecessary engines, and useless materials of every description. (G. C. Greenwell)

Move (No. Wales). A roof which is just about to fall, or is taking weight. (Gresley)

Moya (So. Am.). Volcanic mud, sometimes carbonaceous. Called also Mud lava; applied chiefly to such exudations in South America. (Standard)

Mozo (Mex.). Boy; man of all work; roustabout. (Dwight)

Muck. 1. Earth, including dirt, gravel hardpan and rock, to be, or being excavated; overburden. 2. To excavate or remove muck from. 3. To work hard; to toil. (Webster)
4. (Scot.) Rubbish; soft useless material (Barrowman). *See also* Smut, Dirt, Mullock.
5. A layer of earth, sand or sediment lying immediately above the sand or gravel containing, or supposed to contain, gold in placer mining districts, and may itself contain some traces of gold. (Cook *v.* Johnson, 3 Alaska, p. 516.)

Muck bar. Bar iron which has passed once through the rolls. (Raymond)

Mucker. 1. (U. S.) One who loads mine cars, and, in most mines, is also a trammer pushing the cars to the shaft, tunnel or adit mouth. (Weed)

2. One who excavates earth, or muck (Webster). This term applies more especially to metal mines. *See also* Mullocker.

Muck iron. Crude puddled iron ready for squeezing or rolling. (Webster)

Muckite. A resin from the coal beds at Neudorf, Moravia; it fuses between 290° and 310° C., has a specific gravity of 1.0025, and a composition corresponding to $C_{10}H_{16}O_2$. (Bacon)

Muckle. 1. Soft clay overlying or underlying coal. (Hargis)
2. (Corn.) A large jumper or drill. (Greenwell, p. 217)

Muckle hammer. A scaling or spalling hammer. (Standard)

Muck rolls. The first pair of rolls in a rolling mill. (Standard)

Mucks (Staff.). Bad earthy coal. (C. & M. M. P.) *See also* Smut.

Muck train. A set of muck rolls. (Standard)

Mucky hole. A tap hole from which the iron is so pasty that it does not run freely. (Willcox)

Mud. Moist and soft earth, or earthy matter whether produced by rains on the earthy surface, by ejections from springs and volcanoes, or by sediment from turbid waters; mire. (Century)

Mud bit. A chisel-like tool used in boring wells through clay. (Webster)

Mud bucket. A dredger bucket. (Webster)

Mud cap. A charge of dynamite, or other high explosive, fired in contact with the surface of a rock after being covered with a quantity of wet mud, wet earth, or sand, no bore hole being used. The slight confinement given the dynamite by the mud or other material permits part of the energy of the dynamite being transmitted to the rock in the form of a blow. A mud cap may be placed on top or to one side, or even under a rock, if supported, with equal effect (Du Pont). Also called Adobe, 'Dobie, and Sandblast.

Mud cone. A volcanic cone built up of ejected mud (Webster). *See also* Mud volcano, 2.

Mud cracks. Irregular cracks intersecting the surface of dried mud, or the same more or less filled and hardened into rock, as fossil mud cracks. (Standard)

Mud drag. A dredge for clearing the bottoms of rivers or harbors (Standard). *Compare* Hedgehog, 2. Also called Mud dredge.

Mud drum. A drum forming the lowest part of some steam boilers in which the sediment settles for removal. (Webster)

Mudds (Newc.). Small nails. (Min. Jour.)

Mud fat (Aust.). Unctuous and plastic, like mud. (Standard)

Mud flat. A muddy, low-lying strip of ground by the shore, or an island, usually submerged more or less completely by the rise of the tide. (Century)

Mud geyser. *See* Mud pot.

Mud gun. A steam cylinder operating a plunger inside a steel tube 6 inches in diameter. Clay is fed into the hopper tube as the plunger is worked back and forth and is thus forced into the tap hole, at end of cast. (Willcox)

Mud lava. *See* Moya.

Mud lump. One of numerous mud-discharging cones dotting the shallows at the mouth of the Mississippi; upheaval from lower clays by pressure of surface deposits. (Standard)

Mud marks. The hardened flowings of mud over a smooth surface, or the same petrified, as fossil mud marks. (Standard)

Mud pot (Western U. S.). A geyser that throws up mud. Called also Mud geyser. (Standard)

Mud ring. The ring or frame forming the bottom of a water leg of a steam boiler. (Webster)

Mud scow. A flatboat or barge for the transportation of mud, generally used in connection with dredges. (Century)

Mudsill. The lowest sill of a structure, usually embedded in the soil; the lowest sill or timber of a house, bridge, or dam. (Webster)

Mud socket. A device used on drilling tools to clean mud or sand out of a well. (Webster)

Mudstone. A fine, more or less sandy, argillaceous rock, having no fissile character, and somewhat harder than clay. (Power)

Mud volcano. 1. A hollow cone in a volcanic region, from which material is ejected, by and with various

gases. The usual quiet emissions are interrupted at times by violent discharges, sometimes with columns of flame. Called also Salse, Air volcano, Maccaluba, and Mud cone. (Standard)

Mud-walled. Having a wall of mud, or materials laid in mud instead of mortar. (Century)

Mud wheel. In brickmaking, a wheel by which clay is thoroughly worked with water; a tempering wheel. (Standard)

Muela (Sp.). 1. The upper millstone. 2. The grinding stone of an *arrastré*. 3. *M. vertical*, the runner of a Chilean mill. (Halse)

Muesca (Mex.). A notch in a stick; mortise; notch cut in a round or square beam for the purpose of using it as a ladder (chicken ladder).

Mueseler lamp. A type of safety lamp invented and used in the collieries of Belgium. Its chief characteristic is the inner sheet-iron chimney for increasing the draft of the lamp. (C. and M. M. P.)

Muestra (Sp.). 1. Sample; specimen. 2. *Oficina de muestras*, sampling works. (Halse)

Muestrario (Sp.). A collection of samples obtained by boring. (Halse)

Muff. 1. A cylinder of glass before it is flattened out. (Standard)
2. A joining tube, or coupler, for uniting two pipes end to end. (Century)

Muffle. A semi-cylindrical or long arched-oven (usually small and made of fire clay), heated from outside, in which substances may be exposed at high temperature to an oxidizing atmospheric current, and kept at the same time from contact with the gases from the fuel. Cupellation and scorification assays are performed in muffles, and on a larger scale copper ores were formerly roasted in muffle furnaces (Raymond). Used also in ceramics, for firing pottery specially decorated, as by painting or printing. (Standard)

Muffle furnace. A furnace devised so as to shield its contents from direct contact with the flames. (Webster)

Muffle painting. Decoration, as on china, which will not bear kiln heat, but is fired in a muffle. It is of two kinds, hard and soft. (Standard)

Mufla (Mex.). Muffle. A rude cupel furnace for treating rich ore on a bath of lead. *See also* Vaso. (Dwight)

Muiçalheiro (Braz.). A trammer, shoveler, or helper. (Bensusan)

Mula (Mex.). Mule. (Dwight)

Mulata (Colom.). A compact quartz which is often gold bearing. (Halse)

Mulatto. A local name in Ireland for a Cretaceous green sand. (Kemp)

Mule. 1. A small car, or truck, attached to a rope and used to push cars up a slope or inclined plane. 2. (Joplin, Mo.) An extra man who helps push the loaded cars out in case of up-grade, etc.

Mule skinner. A mule driver. (Crofutt)

Muley brick. An imperfectly pressed brick. (Standard)

Muller. 1. The stone or iron in an arrastre, or grinding or amalgamating pan, which is dragged around on the bed to grind and mix the ore-bearing rock (Raymond)
2. A bucking iron.

Muller's glass. Hyalite, a variety of opal which is as clear as glass and colorless. (Dana)

Mullicite. A variety of vivianite occurring in cylindrical masses. (Dana)

Mulligan. 1. A heavy double-handed sledge for breaking runner scrap at blast furnaces. (Willcox)
2. A miner's term for soup.

Mullock (Eng.). A term sometimes used for the accumulated waste or refuse rock about a mine (Roy. Com.). *See* Muck, the term used in the United States.

Mullocker (Aust.). One who excavates and removes waste rock in distinction to one who removes ore (Webster.) *See* Mucker, which is American usage.

Mullocking (Aust.). Act or process of excavating and removing mullock (Webster). The American term is mucking.

Mullock reefs (Aust.). Reefs in which the matrix of the ore consists of country rock, frequently decomposed eruptive dikes. (Power)

Mullock tip (Aust.). Accumulations of waste rock coming out of a mine; a dump; also, spoil heap. (Raymond)

Mullock vein (Aust.). A decomposed eruptive dike in which the original disseminated gold and silver have been deposited in joints and fissures of the dike rock. This term appears to be unnecessary. (Shamel, p. 165)

Mulniello (Italy). A quarry or place in a coal mine where stone and débris are obtained for the purpose of stowing or filling up goaves. (Gresley)

Multa (Mex.). Penalty or fine. (Dwight)

Multiphase. In electricity, having components of various phase: said of rotating currents or the system employing them. (Standard)

Multiple-bench quarrying. The method of quarrying a rock ledge in a series of successive benches or steps. (Bowles)

Multiple proportions, law of. *See* Dalton's law.

Multiple series; Parallel series. A method of wiring a large group of blasting charges by connecting small groups in series and connecting these series in parallel. (Bowles)

Multiple shot. *See* Battery of holes.

Multure (Peru). The percentage of ore paid to the proprietor of a pulverizing mill as his recompense. (Standard). Derived from grist-mill practice in Scotland.

Mun (Corn). Any fusible metal. (Raymond)

Mundic (corn). Iron pyrite. White mundic is mispickel. (Raymond)

Mungle shale. An oil shale, in the West Calder district, Scotland. (Bacon)

Muñón (Sp.). 1. A trunnion of a Bessemer converter. 2. A gudgeon. (Halse)

Muntz metal. An alloy of copper, 60, and zinc, 40 per cent. (Ure)

Murchisonite. A variety of orthoclase of flesh-red color, resembling perthite. (Chester)

Murex process. A flotation process which is not strictly of the same class as the others, but it still makes use of the principle of selective oiling of sulphide particles. The crushed ore is fed into an agitator and mixed with 4 to 5 per cent of its weight of a paste made of 1 part of oil or thin tar with 3 or 4 parts of magnetic oxide of iron. This oxide must be ground to an impalpable powder. These ingredients, with enough water to make a pulp, are agitated from 5 to 20 minutes. The paste preferentially adheres to the sulphides because of the oil. The ore is then fed over magnets and oxide of iron, with the mineral adhering to it, pulled out. The oil and magnetite are then recovered. (Liddell)

Muriatic acid. The commercial name for hydrochloric acid, HCl.

Muro. (Sp.) 1. A wall. 2. The floor of a deposit, or footwall of a vein. 3. A mine dam. (Halse)

Murphy. *See* Rock drill.

Murra; Murrha (L.). A material first brought to Rome by Pompey, and used for costly vases and cups. It has been variously supposed to be Chinese jade, porcelain, iridescent glass, fluor, etc. (Standard)

Muschelkalk (Ger.). The middle division of the German Triassic (Webster). The word means shell-limestone. Etym., *muschel*, shell, and *Kalkstein*, limestone.

Muscovado. The Spanish word for brown sugar, used by Minnesota geologists for a rusty, brown, outcropping rock that resembles brown sugar. It has been applied to both gabbros and quartzites. (Kemp)

Muscovite. Potash-bearing, white mica, $H_2KAl_3(SiO_4)_3$. *See also* Mica. (U. S. Geol. Surv.)

Muscovitization. The process of changing a mineral, or rock, more or less into muscovite. (Standard)

Muscovy glass. Same as Muscovite. (Century)

Mush. 1. (Leic.) Soft, sooty, dirty earthy coal. (Gresley)
2. A greasy mud, sometimes found on bituminous coal. (Bacon)
3. (Alaska) A march on foot, especially across the snow with dogs. (Webster)

Mushroom hitch (Eng.). An inequality in the floor of a mine due to a projecting stone. (Webster)

Mushroom stone. A fossil resembling a mushroom. (Standard)

Mushy coal (Leic.). Soft, sooty or dirty coal, or coal that has been crushed. Same as Mush, 1. (Gresley)

Muskeg (Mich.). A swamp or bog composed principally of roots, decayed vegetal matter and black soil; it resembles peat, but it is more

earthy and more spongy. In Canada, any rocky basin filled by successive deposits of unstable material, as leaves, muck, and moss incapable of sustaining much weight; hence a large mud-hole.

Muslin glass. Same as Mousseline.

Mussel bind. Same as Mussel band.

Mussel band. A bed of clay ironstone containing fossil bivalve shells, anthracosia, etc. (Gresley)

Muthung (Pr.). A concession of mines from the State, generally about 612 acres, described in plan by straight lines and in depth by vertical planes. (Gresley)

Mutu (Malay). A term denoting the degrees of fineness of gold. (Lock)

Myelin. A soft, yellowish, or reddish-white, clay-like substance, identical with kaolin. (Chester)

Mylonite. A name suggested by the English geologist Lapworth for schists produced by dynamic metamorphism. (Kemp)

Mynpacht (So. Afr.) 1. A mining concession, especially one made by the government to the owner of the surface concerned, and expressed in a *Mynpachtbrief*, or official grant of mining rights. 2. The land owner's mining location, as distinguished from other mining claims on his tract, leased by the government. The land owner is entitled to demand a concession covering one tenth of his surface ownership. (Webster)

N.

Nablock. A rounded mass, as of flint in chalk, or of ironstone in coal. (Standard)

Nacido (Colom.). In placer mining a piece of granite lying on the bedrock in lieu of pay dirt. (Halse)

Naciente (Chile). East. (Halse)

Nacre (Fr.). 1. Resembling pearl, as in iridescence; nacreous; as, the *nacre* enamel of Belleek porcelain. 2. Mother-of-pearl. Also spelled Nacker. (Standard)

Nadel-diorite. Needle-diorite; a German term for diorites with acicular hornblende. (Kemp)

Nadorite. A mineral containing antimony, lead, oxygen, and chlorine, $PbClSbO_2$, occurring in brownish orthorhombic crystals, at Djebel-Nador, Algeria. (Century)

Nagelfluh. A conglomerate rock belonging to the Teritiary of Switzerland (Emmons). Also called Gompholite.

Nager (Brist.). A drill for boring holes for blasting charges. (Gresley)

Nagyagite. A sulpho-telluride of lead, gold, and antimony, possibly $Au_2Pb_{14}Sb_2Te_7S_{17}$. The gold content ranges from 5.8 to 12.8 per cent, the silver from 8.1 to 10.8 per cent. (U. S. Geol. Surv.)

Nahnsen process. An electrolytic process for the refining of impure zinc. Used in Upper Silesia. (Ingalls, p. 576)

Naif. Having a natural luster when uncut; as, a *naif* gem. (Standard)

Naife (Sp.). A diamond in the rough. (Halse)

Nail-head spar. A composite variety of calcite having the form suggested by the name. (Dana)

Nail. A shooting-needle, *which see.*

Nail plate. A plate of metal rolled to the proper thickness for cutting into nails. (Century)

Naked light. A candle or any form of flame lamp that is not a safety lamp (Steel). An open light.

Namma-hole (Aust.). A natural well. (Standard)

Nankin porcelain. Blue china. (Standard)

Nannies (York.). Natural joints, cracks, or slips in the coal measures. *See also* Cleat, 1. (Gresley)

Nantokite. Cuprous chloride, Cu_2Cl_2. Granular, massive. Cleavage cubic. Luster adamantine. Colorless to white or grayish. (Dana)

Napal. (Malay) Indurated white clay carrying auriferous quartz streaks. Called also Steatite. (Lock)

Napalite. A peculiar waxy hydrocarbon C_6H_4, found in the Phoenix mine, near Midletown, Cal.; it has a dark reddish-brown color, is brittle, begins to fuse at 42° C., and boils above 300° C. (Bacon)

Naphtha. 1. As used by ancient writers, a more fluid and volatile variety of asphalt or bitumen. 2. In modern use, an artificial, volatile, colorless liquid obtained from petroleum; a distillation product between gasoline and refined oil. (Century)

Naphtha-gas. Illuminating gas charged with the decomposed vapor of naptha. (Standard)

Naphthalize. To impregnate or saturate with naphtha; enrich (an inferior gas) or carburet (air) by passing it through naphtha. (Century)

Napoleonite. 1. A synonym for Corsite. (Kemp)
2. A variety of hornblende. (Standard)

Nappes (Belg.). Water-bearing strata. (Gresley)

Nariyas. Gold-washers of the N. W. provinces of India. (Lock)

Naris (Sp.). 1. A nose. 2. The nozzle of a bellows. 3. In smelting tin ore, the nose which forms in front of and attached to the tuyère. (Halse)

Narrow (No. of Eng.) A gallery, or roadway, driven at right angles to a drift, and not quite so large in area. (Gresley)

Narrow places (Aust.). Working places that are less than six yards wide; these are paid for by the yard in length. (Power)

Narrow work. 1. All work for which a price per yard of length driven is paid, and which, therefore, must be measured. Any dead work (Steel) 2. (Penn.) Headings, chutes, crosscuts, gangways, etc., or the workings previous to the removal of the pillars. 3. A working place in coal only a few yards in width. 4. A system of working coal in Yorkshire. (Gresley)

Narrow working. *See* Bord-and-pillar method; *also* Narrow work.

Nascent. Coming into existence, beginning to exist or to grow. From L. *nascens*, being born (Webster). A term used in the flotation process.

Nascent state. The condition of an element at the moment of liberation from a compound, marked, as in the case of hydrogen or oxygen, by a chemical activity greater than the ordinary. (Webster)

Nasmyth hammer. A steam hammer, having the head attached to the piston rod, and operated by the direct force of the steam. (Raymond)

Nata (Mex.). Same as *Escoria* or *Grasa*. (Dwight)

Natch. 1. (Scot.) A small hitch or dislocation. 2. (Scot.) The junction of two rails where through improper laying the two are not on the same level or line. (Barrowman)
3. To notch (Webster). A variation of notch.

Native. Occurring in nature pure or uncombined with other substances. Usually applied to the metals, as native mercury, native copper. Also used to describe any mineral occurring in nature in distinction from the corresponding substance formed artificially. (Century)

Native coke. *See* Carbonite, 1; *also* Natural coke.

Native elements. Elements that occur in nature uncombined, as nugget gold, metallic copper, etc. Compare Native.

Native metal. Any metal found naturally in that state, as copper, gold, iron, mercury, platinum, silver, etc. *See also* Native.

Native paraffin. *See* Ozocerite.

Native Prussian blue. Vivianite. (Power)

Native steel. A steel or steely iron occurring in small masses and made by the ignition of coal near an iron-ore deposit. (Standard)

Nativo (Sp.). Native. (Dwight)

Natrium. *See* Sodium.

Natrolite. A mineral of the zeolite family. A silicate of sodium and aluminum, $Na_2O.Al_2O_3.4SiO_2.2H_2O$. (Dana)

Natrometer. An instrument for measuring the quantity of soda contained in salts of potash and soda. (Century)

Natron. Hydrous sodium carbonate, $Na_2CO_3.+10H_2O$.. (U. S. Geol. Surv.)

Natron-Granites. Granites abnormally high in soda, presumably from the presence of an orthoclase rich in soda, or of anorthoclase. They are also called soda-granites. Natron is likewise used as a prefix to minerals and rocks that are rich in soda, as natron-orthoclase, natron-syenite, etc. (Kemp)

Nattle (Eng.). To make a slight broken noise as of rattling (Websted). Said of a mine when movement or settling is taking place.

Natural asphalt. *See* Asphalt.

Natural coke (Aust.). Coal that has been more or less coked by contact with an igneous rock. (Power)

Natural gas. A mixture of gaseous hydrocarbons found in nature; in many places connected with deposits of petroleum, to which the gaseous compounds are closely related. (U. S. Geol. Surv.)

Natural soft porcelain. A porcelain having a body of kaolin and calcium phosphate coated with a lead and boric acid glaze, as Worcester porcelain. (Standard)

Natural steel. Steel manufactured directly from the ore or by refining cast iron. (Standard) Steel in the condition left by a hot-working operation, and cooled in the open air. (Hibbard)

Natural ventilation. Ventilation of a mine without either furnace or other artificial means, the heat being imparted to the air by the strata, men, animals, and lights in the mine, causing it to flow in one direction, or to ascend. (Steel)

Naumanite. A selenide of silver and lead, occurring in large cubical crystals, also granular, and in thin plates of iron-black color and brilliant metallic luster. (Century)

Nautical mile. Equals 1.15136 statute miles. *See* Mile.

Nayfe (Port.). A diamond in the rough. (Halse)

Navite. Rosenbusch's name for Pre-Tertiary, porphyritic rocks, consisting of plagioclase, augite, and olivine as phenocrysts, with a second generation of the same forming the holocrystalline groundmass. The name is from Nava, a locality in the Nahe Valley. (Kemp)

Navvy. (Eng.) 1. The part of the face of an ironstone mine between two roads. (Bainbridge)
2. A machine for excavating earth; more commonly called steam excavator or steam navvy. (Webster)
3. (Eng.) A laborer employed in mining, excavation, railroad work, etc.

Neanthropic. In geology, according to Dawson, the more recent portion of the anthropic, in which the area of land had become, by subsidence, smaller than in the Palanthropic. (Standard)

Neat. Pure; unmixed; undiluted, as a neat cement.

Neck. 1. A lava-filled conduit of an extinct volcano, exposed by erosion (Kemp). Called also Chimney.
2. The narrow entrance to a room next to the entry, or a place where the room has been narrowed on account of poor roof. (Steel)
3. A narrow stretch of land connecting two larger tracts, as an isthmus. 4. A narrow body or channel between two larger bodies of water; a strait. (Webster)
4. In metallurgy, that part of a furnace where the flame is contracted before reaching the stack. 5. In brickmaking, one of a series of walls of unburned bricks in a clamp. (Standard)

Necklace. In ceramics, a necklace-like molding encircling the upper part of a vase or bottle. (Standard)

Neck leathers (Scot.). Washers fixed on the top of a pump bucket or clack lid. (Barrowman)

Needle. 1. A piece of copper or brass about ½-inch in diameter and 3 or 4 feet long, pointed at one end, and turned into a handle at the other, tapering from the handle to the point. It is thrust into a charge of blasting powder in a bore hole, and while in this position the bore hole is tamped solid, preferably with moist clay. The needle is then withdrawn carefully, leaving a straight passageway through the tamping for the miner's squib to shoot or fire the charge. (Du Pont)
2. A hitch cut in the side rock to receive the end of a timber. (Steel)
3. (Scot.) A beam across a shaft at a landing to support the cage; buntons. (Barrowman)
4. A needle-shaped or acicular crystal. (Standard)

Needle ironstone. The capillary variety of göthite. (Chester)

Needle ore. 1. Aikinite. A lead-copper-bismuth sulphide. (Dana)
2. Iron ore of very high metallic luster, found in small quantities which may be separated in long slender filaments resembling needles. (Standard)

Needle spar. An old synonym for Aragonite. (Chester)

Needle stone. *See* Natrolite.

Needle timber (Aust.). Long sticks of timber, the lower end of which rests against the foot of a prop in a steep seam, so as to keep it in position, while the upper end is let into a hitch in the roof. (Power)

Needle valve. A valve provided with a long tapering point in place of the ordinary valve disk. The tapering point permits fine graduation of the opening. At times called a Needle-point valve. (Nat. Tube Co.)

Needle zeolite. Natrolite, scolecite, or any similar mineral having needle-like crystals. (Standard)

Neft-gil; Neftdegil. A mixture of paraffins and a resin occurring on Cheleken Island in the Caspian. It is related to zietrisikite. (Bacon)

Negative crystal. A birefringent crystal in which the refractive index of the extraordinary ray is less than the refractive index of the ordinary ray. (Dana)

Negociación (Sp.). Business undertaking—at a mine, or set of mines, etc. (Min. Jour.)

Negocio (Sp.). Business; enterprise. (Dwight)

Negrillo. (Sp. Am.). 1. A dark-colored silver ore, as argentite, stephanite, etc. 2. A very dark cupriferous silver ore. (Halse)

Negro. 1. (Peru and Chile) A dark fine-textured *caliche*. 2. (Mex.) A lead-gray cinnabar. 3. (Mex.) Tetrahedrite. 4. *Negro-negro* (Colom.), a black micaceous schist. 5. (Mex.) Sulphide silver ores. 6. (Mex.). Iron pyrite containing native silver and argentite. 7. (Mex.) Antimonial gray copper ore mixed with blende, galena, copper, and arsenical iron pyrite. (Halse)

Negrohead, or Niggerhead tuyère. A tuyère having on its end a cubical block which is built into the furnace. (Standard)

Nekoza (Japan). Straw mats specially woven and used for catching gold in the sluices. (Lock)

Nelsonite. A dike rock composed essentially of ilmenite or rutile and apatite. (U. S. Geol. Surv.)

Nemaline. In mineralogy, fibrous or threadlike; said of structure. (Standard)

Nemalite. A fibrous variety of brucite. (Standard)

Neme (Colom.). An oxide of manganese. (Halse)

Neocene. The later of the two epochs into which the Tertiary period was formerly divided and at one time used by many geologists. Also the series of strata deposited during that epoch. It is no longer used. (La Forge)

Neocomian. Of or pertaining to the lower part of the Cretaceous epoch. (Standard)

Neodymium. A rare metallic element occurring in combination with cerium, lanthanum, and other rare metals. Yellowish in color and tarnishes slowly in the air. Symbol, Nd; atomic weight, 144.3; specific gravity, 6.96. (Webster)

Neogen. An alloy resembling silver, containing copper 58 parts, zinc 27, tin 2, nickle 12, bismuth ¼ part, and aluminum ¼. (Standard)

Neogene. The later of the two periods into which the Cenozoic era is divided in the classification adopted by the International Geological Congress and used by many European geologists. Also the system of strata deposited during that period. It comprises the Miocene, Pliocene, Pleistocene, and Holocene or Recent epochs. *See* Paleogene. (La Forge)

Neo-Jurassic. Pertaining to, or occurring in, certain Upper Jurassic beds in Portugal, which are mainly correlated with the Kimmeridge beds, and with some beds in the United States. (Standard)

Neolite. A silky, fibrous, stellated, green, hydrous, magnesium-aluminum silicate. (Standard)

Neolithic. Designating, pertaining to, or belonging to a stage of human culture following the paleolithic and characterized by an advance in civilization denoted by more and better implements of stone, bone, and horn, by the beginning of agriculture, and the presence of domestic animals. (Webster)

Neolote. A name used by Clarence King for an order of volcanic rocks embracing the rhyolites and basalts with which, according to the succession formulated by von Richthofen, eruptive activity terminates in any given area. (Kemp)

Neon. An inert gaseous element found in the atmosphere, of which it constitutes one or two thousandths of a per cent by volume. Symbol, Ne; atomic weight, 20.2; specific gravity, 0.69. (Webster)

Neo-Paleozoic. The later portion of Paleozoic time, including the Upper Siluric, Devonic, and Carboniferous. (Standard)

Nevolcanic. Of effusive character and erupted during the Cenozoic era: formerly said of some igneous rocks, but now virtually obsolete. Contrasted with Paleovolcanic. (La Forge)

Neozoic. Pertaining to or designating the entire period from the end of the Mesozoic to the present time. Cenozoic. (Webster)

Nepheline. Same as nephelite.

Nephelinite. A granular to aphanophyric igneous rock composed essentially of nephelite and pyroxene. (La Forge)

Nephelinitoid. Boricky's term, now used in microscopic work for nepheline-glass, or the glassy basis in nepheline rocks, whose easy gelatinization indicates its close relations with this mineral; unindividualized nephelite. (Kemp)

Nephelite. An orthosilicate of sodium, potassium, and aluminum, $(Na, K)_2Al_2Si_2O_{8}$ (Dana). Also called Nepheline.

Nephelite-basalt. An old, general name for basaltic rocks with nephelite, but now restricted to those that practically lack plagioclase, and that have nephelite, augite, olivine, and basis. (Kemp)

Nephelite-basanite. Basaltic rocks with plagioclase, nephelite, augite, olivine, and basis. *Compare* Nephelite-tephrite. (Kemp)

Nephelite-syenite. A granular igneous rock consisting of orthoclase, nephelite, and one or more of the following: hornblende, augite, and biotite. The rock results from magmas especially rich in alkalies, and possesses great scientific interest on account of its richness in rare, associated minerals. (Kemp)

Nephelite-tephrite. A gray, volcanic rock composed of pyroxene, plagioclase, nephelite, and magnetite. (Standard)

Nephrite. *See* Jade.

Neptune powder. An explosive resembling dynamite No. 2, and consisting of nitroglycerin with a more or less explosive dope. (Raymond)

Neptunian. An early term applied to water-formed strata as opposed to plutonic or igneous rocks. (Power)

Neptunist. One who held the theory that the successive rocks of the earth's crust were formed by the agency of water (Webster). Usage obsolete.

Nereite. A fossil worm track. (Webster)

Nero-antico (It.). A black marble found in Roman ruins: probably the ancient *marmor taenarium*, from Cape Taenarus, Greece. (Standard)

Nervio (Sp.). A parting in a seam of coal. (Halse)

Nesh (Eng.). Friable, soft, crumbly, powdery, dusty. Said of coal. (Gresley)

Nesquehonite. A hydrous, magnesium carbonate, $MgCO_3+3H_2O$. In radiating groups of prismatic crystals. Colorless to white. From a coal mine at Nesquehoning, Pa. (Dana)

Ness; Naze. A cape, headland, or promontory most commonly used as a termination, as in Dunge*ness*.

Nessler's solution. An aqueous solution of potassium and mercuric iodide, made strongly alkaline with potassium hydroxide. (Webster)

Nest. A small isolated mass of any ore or mineral within a rock. (Webster)

Nested crater. A central volcanic vent showing a crater within a crater. (Daly, p. 144)

Nest-weise (Forest of Dean). Iron ore that occurs in pockets is said to lie nest-weise. (Gresley)

Net (Scot.). Strapping used for lowering or raising horses in shafts. (Barrowman)

Nether coal (Mid.). The lower division of a thick seam of coal. (Gresley)

Nether-formed. Formed or crystallized below the earth's surface, as granite. (Standard)

Net masonry. Masonry formed of small square bricks or stones placed diagonally in a lozenge pattern; reticulated masonry. (Standard)

Neudorfite. A resin, $C_{12}H_{20}O_2$, that occurs in a coal bed at Neudorf, Moravia. (Bacon)

Neutral. Of slags, neither acid nor basic; of wrought-iron, neither red-short nor cold-short; of iron ores, suitable for the production of neutral iron. (Raymond)

Neutral oil. 1. An oil of 32° to 36° Bé. gravity, 290° to 318° F. flash point, and 47 to 81 sec. Saybolt viscosity at 70° F. It is sometimes mixed with animal or vegetal oils.

2. The paraffin oils that are obtained by the steam-distillation of paraffin-base petroleums after the second-grade illuminating oil has been run off. Neutral oil carrying paraffin is known as Wax distillate. (Bacon)

Neutral salt. A salt in which all of the hydrogen of the hydroxyl groups of an acid is replaced by a metal (Standard). As, in sodium chloride, NaCl, the sodium has replaced the hydrogen of hydrochloric acid, HCl.

Nevada system. *See* Square-set stoping.

Nevadite. A rhyolite that approximates a granitoid texture, *i. e.*, with little groundmass. (Kemp)

Névé. The mass of granular snow forming the upper part of a glacier. Also called Firn. (Webster)

Nevyanskite. A tin-white alloy of iridium and osmium with other platinum metals occurring in flat scales (Standard). Contains over 40 per cent iridium. (Dana)

Newaygo screen. A slanting screen down which the material to be screened passes. The screen is kept in vibration by the impact of a large number of small hammers. (Liddell)

Newkirkite. An early synonym for Manganite. (Chester)

New red sandstone. The assemblage of red sandstone, conglomerates, shales, etc., occupying the interval between the top of the Coal Measures and the base of the Jurassic system in western Europe. It is now separated into Triassic and Permian and the name has only a historic interest. (La Forge)

New sand. Newly mixed, but not unused, molder's sand. (Standard)

Newton's alloy. An alloy containing 20 per cent bismuth, 50 lead, and 30 tin. Melting point, 202.1° F. (Webster)

N-Frame brace. A diagonal brace in a square set. (Sanders, p. 49)

Niccoliferous. *See* Nickeliferous.

Niccolite; Arsenical nickel. Arsenide of nickel, NiAs. Contains 43.9 per cent nickel (U. S. Geol. Surv.). Also called Copper nickel. (Standard)

Nicholsonite. A variety of aragonite (the orthorhombic carbonate of calcium, $CaCO_3$, containing from less than 1 per cent up to 10 per cent of zinc. (U. S. Geol. Surv.)

Nick. To make a cut, with the pick, in the face of (coal) at the junction of the face and rib, to weaken resistance to the blast or wedge; to shear. (Standard). *See* Nicking.

Nickel. A hard, malleable, ductile, metallic element of the iron group, nearly silver-white, capable of a high polish and resistant to oxidation. It is attracted by magnets. Symbol, Ni; atomic weight, 58.68; specific gravity, 8.8. (Webster)

Nickel bloom. *See* Annabergite.

Nickel carbonyl. A colorless, poisonous liquid, $Ni(CO)_4$, obtained by passing carbon monoxide over finely divided nickel. (Webster)

Nickel glance. Same as Gersdorffite. (Standard)

Nickel gymnite. A gymnite in which part of the magnesium is replaced by nickel. A synonym for Genthite. (Chester)

Nickeliferous. Containing nickel.

Nickeline. 1. An alloy of nickel, a variety of German silver. 2. An alloy of nickel, copper, zinc, iron, cobalt, and manganese. (Webster)

Nickel ocher. An early name for Annabergite. (Chester)

Nickel silver. An alloy resembling German silver but containing more nickel; used by jewelers. (Standard)

Nickel skutterudite. A mineral of the skutterudite type, containing nickel. An arsenide of nickel and cobalt, of gray color and granular structure. (Chester)

Nickel steel. An alloy of iron and about 3 per cent nickel, combining great strength with great ductility and nonfissility; used for the best armor plates. (Standard)

Nickel vitriol. Same as Morenosite. (Standard)

Nicking. 1. A vertical cutting or shearing up one side of a face of coal. Called Cut, and Cutting. 2. The chipping of the coal along the rib of an entry, or room, which is usually the first indication of a squeeze. (Steel)

Nickings (Newc.). The small coal produced in making the nicking (Duryee). *See also* Bug dust; Makings.

Nicking trunk. A tub in which metalliferous slimes are washed. (Raymond)

Nicol prism. An instrument for experiments in polarized light, consisting of a rhomb of clear calcite which has been bisected obliquely at a certain angle and had its two parts again joined with transparent cement, so that the ordinary ray produced by double refraction is totally reflected from the internal cemented surface, and the extraordinary, or polarized, ray is alone transmitted. (Webster)

Nicopyrite. A variety of pyrite containing nickel. An old synonym for Pentlandite. (Chester)

Nidge (Eng.). To dress, as stone, with a sharp-pointed hammer. Same as Nig. (Standard)

Nido (Sp.). Nodule. (Lucas)

Niello. 1. Any of several metallic alloys of sulphur, with silver, copper, lead, or the like, having a deep-black color. 2. Art, process, or method of decorating metal with the black alloy. 3. A piece of metal, or any other object so decorated. (Webster)

Niello silver. A bluish alloy of silver, lead, copper, and bismuth, with admixture of sulphur. Called also Russian tula. (Standard)

Nig (Eng.). To dress, as stone, with a sharp-pointed hammer. Same as Nidge. (Standard)

Nigger ashlar (Corn.). A mode of dressing stone, in which the face is left rough. (Crofutt)

Niggerhead. 1. A bowlder or rounded field stone. 2. A black nodule found in granite. 3. Slaty rock occurring with sandstone (Gillette, p. 6). *See also* Hardhead, 2 and 3.
4. A hard, round piece of rock, sometimes found in coal seams. (Roy)
5. A slip pulley on a winch. The rigger takes about six turns of rope about the pulley, and by varying tension on rope which he holds, can vary speed of hoist on lowering object with engine running. (Willcox) 6. *See* Negrohead.

Night fossicker (Aust.). One who robs gold-diggings in the night (Standard). *See* Fossick; Fassicker.

Night pair (Corn.). Miners who work underground during the night. (Pryce). The night shift.

Nigrine. A ferriferous rutile. (Dana)

Nigrite. 1. A name given to a variety of asphalt mined at Soldier summit, Utah, but whose composition is imperfectly understood. (U. S. Geol. Surv.) 2. An insulating composition consisting of the impure residuum obtained in the distillation of paraffin. (Standard)

Nihil album; Nil album. *See* Zinc oxide.

Nil. Nothing; a thing of no account (Webster). Often used in reporting gold and silver assays.

Nill. 1. Scales of hot iron thrown off during forging. 2. More rarely, sparks of brass during manufacture. (Standard).

Niobio (Sp.). Niobium. (Dwight)

Niobium. A later name for Columbium. (Webster).

Nip. 1. (Newc.) A crush of pillars or workings. *See* Pinch, 1. (Raymond)
2. (So. Wales). A thinning of a coal bed in which the roof and floor come nearly together. 3. To cut grooves at the ends of bars, to make them fit more evenly. (Gresley)
4. *See* Angle of nip.

Nip out. The disappearance of a coal seam by the thickening of the adjoining strata, which takes its place. (C. and M. M. P.)

Nipped. Pinched: applied to veins when they become narrower or thinner than usual. (Power)

Nipper. 1. An errand boy, particularly one who carries steel, bits, etc., to be sharpened. (C. and M. M. P.)
2. (Eng) A tool used by the lander for seizing the kibble, and upsetting it into the wheelbarrow. (Hunt)
3. In coal mining, a trapper or door boy.

Nipping fork. A tool for supporting a column of bore rods while raising or lowering them. (Raymond)

Nipple (Mid.). *See* Fissle. A word used to express the crepitant noises made by the settling down or weighting of the roof. (Gresley)

Niquel (Sp.). 1. Nickel; *N. bronce*, nickel-bronze. 2. Nickel ore. *N. arsenical*, niccolite. (Halse)

Nissen stamp. A gravity stamp with an individual circular mortar for each stamp. (Liddell)

Niter; Saltpeter. Potassium nitrate, KNO_3. (U. S. Geol. Surv.)

Niter cake. Crude sodium sulphate, a by-product in the manufacture of nitric acid from sodium nitrate. (Century)

Niton. A colorless gas resembling argon; radium emanation. Symbol Nt; atomic weight, 222.4. (Webster)

Nitral (Sp.). A niter bed or deposit. (Halse)

Nitrate. 1. A salt of nitric acid, as silver *nitrate;* barium *nitrate.* (Standard)
2. To treat or prepare with nitric acid; to convert a base into a salt by combination with nitric acid. (Century)

Nitratine. Same as soda-niter. (Standard)

Nitreria (Sp.). Niter or saltpeter works. (Halse)

Nitric acid. A colorless highly corrosive liquid, HNO_3, found in nature in small quantities, but usually made by decomposing sodium or potassium nitrate with sulphuric acid. It is extensively used in the arts for dissolving metals. Called also *Aqua fortis.* (Standard)

Nitrite. A salt of nitrous acid. (Standard)

Nitro. A corrupted abbreviation for nitroglycerin or dynamite. (Ihlseng)

Nitrobarite. Native barium nitrate, $Ba(NO_3)_2$. (Standard)

Nitrocalcite. Hydrous calcium nitrate, $Ca(NO_3)_2+nHO$. (Dana)

Nitrocellulose. A term used to include the various nitrates of cellulose, such as guncotton, nitrolignine, nitrocotton, nitrojute, etc. The most common of these is nitrocotton. (Du Pont)

Nitrocotton. A chemical combination of ordinary cotton fiber with nitric acid. It is explosive, highly inflammable and in certain degrees of nitration, soluble in nitroglycerin. (Du Pont)

Nitrogelatin. Same as Gelatin dynamite. (Standard)

Nitrogen. A colorless, gaseous element, tasteless and odorless, constituting about four fifths of the atmosphere by volume. Symbol, N; atomic weight, 14.01; specific gravity, 0.967. (Webster)

Nitroglycerin. The product of the action of nitric acid and sulphuric acid on glycerin. It is not properly a nitro compound as the name implies but is a nitric ester of glycerin. (Brunewig, p. 253).
It is an oily substance about one and one-half times as heavy as water (Sp. gr. 1.6), is almost insoluble in water, and is used as a principal or active ingredient in dynamite, gelatin dynamite, etc. It is not used commercially in the form of a liquid, except for 'shooting' oil wells. (Du Pont)

Nitrohydrochloric acid. A yellow, fuming, corrosive liquid, made by mixing one part of pure nitric acid with from three to four parts of pure hydrochloric acid. It dissolves gold and platinum, and hence is called Aqua regia, *also* Nitromuriatic acid. (Standard)

Nitromagnesite. A hydrous magnesium nitrate, $Mg(NO_3)_2+nH_2O$. (Dana)

Nitromuriatic acid. *See* Nitrohydrochloric acid.

Nitro-substitution. The act or process of introducing by substitution the radical nitryl (NO_2) in place of one or more replaceable hydrogen atoms, as in an organic compound (Standard). *Nitro-substitution* compounds are used in the manufacture of certain kinds of explosives.

Nitrosulphuric acid. An exceedingly corrosive mixture of one part of nitric acid mixed with two parts by weight of sulphuric acid. It is used in the manufacture of nitroglycerin. (Standard)

Nitrosyl sulphuric acid. A colorless white crystalline acid, $H(NO)SO_4$, formed by the reaction of sulphuric acid with oxides of nitrogen (not N_2O), by the reaction of sulphur dioxide with nitric oxide, or nitrogen peroxide, etc. (Webster)

Nitting (Eng.). The refuse from workable ore. (Standard)

Nivation. In geology, the specific effects produced by *névé* in land sculpture: distinguished from those of glacier ice, called glaciation. (Standard)

Nivel (Sp.). 1. A level, as a leveling instrument. 2. Level. 3. A level or gallery in a mine (Halse). *N. de agua,* water level. (Min. Jour.)

Nivelación (Sp.). Leveling; grading. (Halse)

Nivenite. A variety of uraninite high in uranium and carrying 10 per cent or more of the yttrium earths and 6.7 to 7.6 per cent thoria. It is wholly soluble in dilute sulphuric acid. *See also* Uraninite. (U. S. Geol. Surv.)

Noble. A term used in mineralogy to express superiority or purity, *e. g.*, noble opal, noble tourmaline, noble serpentine, etc. (Power)

Noble metals. The metals which have so little affinity for oxygen (*i. e.*, are so highly electronegative) that their oxides are reduced by the mere application of heat without a reagent; in other words, the metals least liable to oxidation under ordinary conditions. The list includes gold, silver, mercury, and the platinum group (including palladium, iridium, rhodium, ruthenium, and osmium). The term is of alchemistic origin. (Raymond)

Nocking (Corn.). *See* Knocking, 2; *also* Cob, 1.

Noddle; Nodule. A small rounded mass. (Raymond)

Nodular. Having the shape of or composed of nodules. (La Forge.) Said of certain ore.

Nodule. A small roundish lump of some mineral or earth, as a nodule of ironstone. (Webster)

Nodulize. To convert into nodules, as finely divided ores. (Webster)

Nódulo. 1. (Sp.) Nodule. 2. (Colom.) A place in a lode where the ore is abundant. (Halse)

Nog. 1. (Eng.) Logs of wood piled one on another to support the roof, largely used in longwall mining (Chance). *See* Chock, Crib and Cog.
2. A square block of wood used in the support of a mine roof. (Standard)
3. (Derb.) A piece of iron driven into wood to prevent forks (props) getting loose. (Mander)

Noger. A jumper drill. (Raymond)

Nogging. 1. Rough brick masonry used to fill in the open spaces of a wooden frame. (Webster)
2. Pieces of wood inserted in a masonry wall, to stiffen it, or upon which to nail finishing stuff. (Standard)

Nogging piece. A horizontal timber set in between courses in a wall of masonry. (Standard)

Nolascite (Chile). A variety of galenite containing arsenic. (Chester)

Nolichucky shale. A Cambrian formation of the Southern Appalachians. From the Nolichucky river in Tennessee. (Webster)

Nominal horsepower. A term used by some engine makers to express certain measurements of cylinder. (Webster)

Nominal rate. In finance, the rate that would be realized if the interest received at the end of each conversion interval were not profitably invested until the end of the year, while the *effective rate* is the total return on the unit principal for one year. (E. B. Skinner, p. 59)

Nominal selling price (Aust.). *See* Declared selling price.

Noncoking coal. A bituminous coal that burns freely without softening or any appearance of incipient fusion. The percentage of volatile matter may be the same as for coking coal, but the residue is not a true coke. (Bacon)

Nonconformable. *See* Unconformity.

Nonesite. Phorphyrites with orthorhombic pyroxene. The name was given by Lepsius. (Kemp)

Nonmetal. An element that is not a metal. Any of several elements, as boron, carbon, phosphorus, nitrogen, argon, oxygen, sulphur, etc. (Webster)

Nonmetallic. Not metallic. Of, pertaining to, or of the nature of, a nonmetal. (Webster)

Nonseat (Mid.). *See* D-Link.

Nonwetted. A term used in the flotation process, and applied to certain metallic minerals that refuse to be wetted with water but are easily wetted with oil.

Nook. 1. The corner of a working place at the junction of the face with one side. (C. and M. M. P.)
2. (No. of Eng.) A corner of a pillar of coal (Gresley). Also spelled Neuk.

Nooper (Leic.). A tool used by colliers for preparing coal. *See also* Dresser, 1. (Gresley)

Noper (Derb.). *See* Loading pick.

Noque. 1. (Peru) *See* Cocha. 2. (Chile) A large stone receptacle for the calcination of ore in the open air. A stone trough in which amalgam is washed. (Halse)

Nordhausen acid. Fuming sulphuric acid, $H_2SO_4SO_3$.

Nordmarkite. Brögger's name for a sodic variety of syenite consisting of orthoclase, some oligoclase, more or less microperthite, quartz and somewhat subordinate biotite, pyroxene, hornblende and ægerite. Nordmarkites are high in silica and the alkalies. (Kemp)

Noria (Sp.). An endless chain with buckets attached, revolving around a wheel about 20 feet in diameter for raising water out of a shallow mine. (Halse)

Norite. A variety of gabbro consisting of plagioclase and orthorhomic pyroxene, usually hypersthene. The name has had a variable history and was originally proposed in 1832 by Esmark for aggregates of feldspar and bornblende which were lacking or notably poor in diallage and hypersthene. But as many localities were cited which in later years on microscopic examination were found rich in these minerals, Rosenbusch finally gave the name its above definition and this is its generally accepted signification. (Kemp)

Norm. A theoretical, and in part arbitrary, mineral composition of a rock, calculated, in accordance with certain rules, from the chemical analysis, for the purpose of assigning the rock its place in the *norm* system of rock classification. The norm rarely coincides with the real mineral composition, or *mode*, of a rock (Ransome). *Compare* Mode.

Normal benzine. Benzine of the specific gravity 0.695–0.705 at 15° C. and boiling from 65°–95° C. (Bacon)

Normal fault. An inclined fault of which the down-thrown side is the hanging-wall side. (La Forge). Also called Tension fault or Gravity fault (Steel). *See also* Fault.

Normal fold. An anticline, or syncline, with equal dips on each side; in contradistinction to an *overthrow fold*. (Power)

Normalized steel. Steel that has been given a normalizing heat treatment intended to bring all of a lot of samples under consideration into the same condition. (Hibbard)

Normal pressure. Standard pressure, usually taken to be equal to that of a column of mercury 760 mm. in height (Webster). Approximately 14.7 pounds per square inch.

Normal price. As applied to metal prices, is the average over a long term—sometimes a period greater than the life of a mine. *See also* Basic price. (H. C. Hoover, p. 36)

Normal-pyroxenic. Bunsen's name for his assumed, typical, basic, igneous magma with 48 per cent SiO_2 as contrasted with the corresponding normal-trachytic one with 76 per cent SiO_2. He sought to explain all intermediate rocks by the intermingling of these two. Although apparently applicable at times and serviceable in their day, the conceptions have long since exploded. (Kemp)

Normal salt. A salt in which all the hydrogen of the acid has been replaced by metals. (A. F. Rogers)

Normal shift. The horizontal component of the shift at right angles to the fault strike. (Lindgren, p. 122)

Normal solution. A solution containing one gram-equivalent of the solute in one liter of solution.

Normal temperature. In laboratory investigations, 25° C. or 77° F. (Bacon)

Norman tile. Brick having the dimensions 12 by 2¼ to 2½ by 4 inches. (Ries)

Normative. In petrology, characteristic of, pertaining to, agreeing with, or occurring in the norm: used in the quantitative or norm system of classification of igneous rocks, a normative mode being one which is essentially the same as the norm. (La Forge)

Norm system. A system of classification and nomenclature for igneous rocks based on the *norm* (*which see*) of each rock. Only undecomposed rocks of which accurate chemical analyses are available are classifiable, in this system, which consequently is more used in detailed petrologic studies than in ordinary geologic or mining work. The system was devised by Messrs. Cross, Iddings, Pirsson, and Washington, and by them originally designated "the Quantitative System," and later the "C. I. P. W. System." It has also been referred to as the "American System." (Ransome)

Norte (Sp.). North. (Dwight)

North end (York.). The rise side of the coal in North Yorkshire. (Greeley)

Northing. In surveying, difference of latitude, measured toward the north, between any position and the last one determined. (Standard)

North Staffordshire method. *See* Bord-and-pillar method.

Nose. 1. An accumulation of chilled material around the inner end of a tuyère in a smelting shaft furnace, protecting and prolonging the tuyère. (Raymond)
2. (Scot.) A point; a projecting angle of coal or other mineral. (Barrowman)
3. To dip or extend in noselike form; said of strata or veins. (Webster)

Nosean. *See* Noselite. The name of the mineral is often prefixed to the names of rocks containing it. (Kemp)

Nose helve Eng.). *See* Frontal hammer.

Nose hole. In glass making, a small opening in a furnace, before which the globe of crown glass is held and kept soft at the beginning of the flattening process. (Webster)

Nose-in (Eng.). A stratum is said to "nose in" when it dips beneath the ground into a hillside in a V or nose form. (Gresley)

Noselite. A mineral of the sodalite group, near haüynite, but containing little or no lime. (Dana)

Nose-out. 1. (Eng.) A nose-shaped stratum cropping out. (Gresley)
2. To diminish by losing stratum after stratum and getting into the lower part of the measure; said of a coal seam. (Standard)

Nose pipe. The inside nozzle of a tuyère. (Standard)

Notching. A method of excavating in a series of steps. (Standard)

Notch stick (Forest of Dean). A short stick notched or nicked, used by miners as records of the number of cars of coal, etc., they send out of the mine during the day. (Gresley)

Notice board (Scot.). A board on which printed or written notices are posted (Barrowman). A bulletin board.

Nottingham longwall, or Barry, system. *See* Longwall method.

Noumeite. Same as Garnierite. (Dana)

Nouvelle Montagne furnace. A modification of the Liège furnace, in so far as the arrangement of the fireplace is concerned. It is a double furnace served by one fireplace. (Ingalls, p. 431)

Novaculite. An excessively fine-grained, quartzose rock supposed to be a consolidated, siliceous slime and of sedimentary origin. It is especially developed in Arkansas, and much used as a whetstone. (Kemp)

Nowel. 1. The inner part of a large mold, corresponding to the core in small work. 2. The bottom or drag of a molding flask, as distinguished from the cope. (Standard)

Noxious. Causing or tending to cause injury, especially to health or morals; hurtful; pernicious; as, *noxious* gases, etc. (Standard)

Nozzle. 1. A short tube, usually tapering, forming the vent of a hose or pipe. (Webster)
2. The front nose-piece of a bellows or a blast pipe for a furnace. (C. and M. M. P.)
3. A short piece of pipe with a flange on one end and a saddle flange on the other end. May be made of cast-iron, cast-steel or wrought-steel. 4. A side outlet attached to a pipe by such means as riveting, brazing, or welding. (Nat. Tube. Co.)

Nubber (Mid.) A block of wood about twelve inches square, for throwing mine cars off the road in case the couplings or ropes break. (Gresley)

Nucleus. A kernel; a central mass or point about which other matter is gathered, or to which an accretion is made. (Webster)

Nudo (Mex.) Knot or button on traction-rope of tramway; coupling. (Dwight)

Nug. 1. (Scot.) The dull sound caused by breaking strata. (Barrowman)
2. (Eng.). A knot; protuberance; lump; block. (Webster)

Nugget. A water-worn piece of native gold. The term is restricted to pieces of some size, not mere 'colors', or minute particles. Fragments and lumps of vein-gold are not called 'nuggets,' for the idea of alluvial origin is implicit. (Min. and Sci. Press. Apr. 17, 1915.) A lump of native gold, silver, platinum, copper, etc. (Roy. Com.)

Nuggeting. Searching for nuggets of gold. (Webster)

Nuggety. Like or resembling a nugget; occurring in nuggets; also abounding in nuggets. (Webster)

Nullah (Hind.). A small stream or brook. Generally a heavy torrent during the rainy season, and a dry, sandy channel at other times (Oldham). Often containing auriferous sands.

Numidian marble. A general name given to some celebrated marbles of cream, yellow, pink, and red colors, found in northern Africa. According to the best authorities the name Numidian is incorrect, the true source of the stone being not Numidia, but the provinces of Africa and Mauritania. The quarries were worked by the ancient Romans. (Merrill)

Nummulite limestone. An Eocene formation made up chiefly of nummulite shells. (Webster)

Nunatak (Eskimo). An insular hill or mountain surrounded by an ice sheet. (Lahee, p. 322)

Nusco (Peru). A mixture of iron and manganese oxides, with foliated talc and quartz, containing gold. (Halse)

Nut coal. An abbreviation for chestnut coal. Also called Nuts.

Nuts. Small coal. (Raymond)

Nuzco (Peru). 1. Small coal. 2. Ore broken to the size of a walnut. (Halse)

Nystagmus. A rapid involuntary oscillation of the eyeballs. It may be congenital, associated with ocular troubles or of nervous origin (Webster). A disease among miners due to working in poor light. *See* Miner's nystagmus.

O.

Oakum. 1. Hards or tow of flax or hemp, used for calking seams, stopping leaks, etc. 2. The material obtained by untwisting and picking into loose fiber old hemp ropes. (Webster)

Oamaru stone (Aust.). A white, granular limestone found in large quantities in Oamaru, New Zealand, valued as a building stone. (Standard)

Oberbergamt (Pr.). A board or council consisting of six or seven members, which sanctions colliery rules, prescribes as to the duties of inspectors, as related to fiery mines, safety lamps, etc. (Gresley)

Obersteiger (Pr.). An underground overman, who acts under the guidance of the manager. (Gresley)

Oblicuo (Sp.). Oblique. (Halse)

Oblique block. A quarry term applied to a block of stone bounded by three pairs of parallel faces, four of the twelve interfacial angles being right angles, four obtuse, and four acute. (Bowles)

Oblique fault. *See* Fault.

Oblique lamination. Same as Transverse lamination.

Oblique slip fault. *See* Fault.

Obra (Sp.). 1. Work. 2. Mine workings. 3. The narrow prismatic part of a blast-furnace immediately above the crucible (Halse). 4. *Obras de disfrute*, workings from which ore is being extracted. 5. *Obras muertas*, literally, dead work; work done in the country rock. (Dwight)

Obradora buena (Mex.). Rock that breaks well.

Obradora mala (Mex.). Rock that breaks badly.

O'Brien furnace. A roasting furnace of the Herreshof type with central vertical shaft carrying stirring arms. (Ingalls, p. 154)

Obrizo (Sp.). High-grade gold. (Lucas)

Obsequent. Flowing in a direction opposite to that of the dip of the strata or the tilt of the surface: said of some streams and contrasted with Consequent. (La Forge) Called also Reversed stream.

Obsidian. 1. Extrusive igneous rocks which have cooled either without crystallization or with only partial crystallization. (U. S. Geol. Surv.) 2. A general name for volcanic glass. When used alone it implies a rhyolite-glass, but it is now much employed with a prefix as andesite-obsidian, basalt-obsidian. (Kemp)

Obsidiana (Sp.). Obsidian; volcanic glass. (Halse)

Obtuse bisectrix. That axis which bisects the obtuse angle of the optic axes of biaxial minerals. (Dana)

Occidental amethyst. *See* Oriental amethyst.

Occidental diamond (Eng.). A lapidary's term for limpid and colorless varieties of rock crystal when cut and polished. Used in contradistinction to the Oriental or true diamond. (Page)

Occlude. To take in and retain in pores or other openings; to absorb; said especially with respect to the absorbing of gases by certain substances which do not thereby lose their characteristic properties; as charcoal, iron, platinum and palladium occlude large volumes of hydrogen, palladium nearly a thousand times its own volume (Webster). A term used in flotation processes.

Occlusion. The mechanical retention of gases in the pores of solids (Raymond). *See* Occlude.

Occupation. The word used to describe the mode of acquiring rights to mining claims. (Collins *v.* Bubb, 73 Fed. Rept., p. 739)

Occurrence. In geology, the existence or presence of anything or phenomenon in any special position, or in any specified relations to other objects or phenomena, as the *occurrence* of gold in a vein. (Standard)

Ocean coal (Cumb.). Coal seams lying beneath the sea. (Gresley)

Ocellar. Of, or pertaining to, or designating, a type of rock structure characterized by radiated, eyelike aggregates. (Webster)

Ocher. A pulverulent iron oxide usually impure, used as a pigment: brown and yellow ochers consist of limonite, or goethite, and red ocher of hematite. Similar pulverulent oxides of several other metals, also used as pigments, are sometimes called ochers, generally with the name of the metal prefixed, as antimony ocher, cadmium ocher. (La Forge). Also spelled Ochre.

Ocre (Sp.). Ocher. (Dwight)

Octad. An atom or radical that has a valence of eight. (Webster)

Octahedral cleavage. In the isometric system, cleavage parallel to the faces of the octahedron. (La Forge)

Octahedral iron ore. Magnetite. (Webster)

Octahedrite. A tetragonal form of titanium dioxide, TiO_2, in brown, dark blue, or black crystals. (Dana)

Octahedron. In the isometric system, a closed form of eight faces each having equal intercepts on all three axes. (La Forge)

Octavalent. In chemistry, having a valence or combining power of eight. (Standard)

Octibbenite. In mineralogy, a metallic alloy of iron and nickel, unusually rich in the latter element. (Standard)

Odd-knobbing (So. Staff.). Breaking off the coal from the sides in the thick-coal workings. (Gresley)

Odd man (Eng.). One who works by the day at sundry jobs in the mine. (Gresley)

Oddside. A permanent impression or mold of part of a pattern, used by molders in like manner to a false part. *See also* False part. Standard)

Odd work. Work other than that done by contract, such as repairing roads, constructing stoppings, dams, etc. (Gresley)

Odinite. A lamprophyric variety of basalt occurring in dikes in Mt. Melibocus. It has a groundmass of plagioclase and hornblende rods, with phenocrysts of plagioclase and augite. (Kemp)

O'erlayer (Derb.). A piece of wood on which the sieve is placed after washing the ore in a vat. (Min. Jour.)

Oeste (Sp.). West. (Dwight)

Off (No. of Eng.) Worked out; gotten; wrought (Gresley). As the mine is off.

Off-bear. To carry (bricks) from the molding table and deposit on the drying floor. (Standard)

Off-bearer. A workman employed to carry bricks from the molding table and lay them on the ground to dry. (Century)

Off gates (No. of Eng.). Goaf roadways in longwall workings about 120 yards apart. (Gresley)

Off-putter (Eng.) A loader of coal into a vessel at a staith or spout; a colliery agent at a quay. (Webster)

Offset. 1. In surveying, a short distance usually measured at right angles from a line as to a boundary, or to continue a line parallel to itself at some little distance away to avoid an obstruction or the like. 2. A short drift or crosscut driven

from a main gangway or level. 3. The horizontal distance between the outcrops of a dislocated bed. (Lindgren, p. 120)
4. A spur or minor branch from a principal range of hills or mountains. (Century)

Offset staff. In surveying, a rod, usually ten links long, used in measuring short offsets. (Webster)

Offtake. 1. (Eng.) The raised portion of an upcast shaft above the surface, for carrying off smoke, steam, etc. 2. The length of boring rods unscrewed and taken off at the top of the bore hole, depending upon the height of the head-gear and depth of the well. (Gresley)
3. (Scot.) A deduction from workmen's wages for house rent, coal, etc. (Barrowman)
4. A channel for taking away air or water; also the point of beginning of such a channel. (Webster)

Offtake drift; Offtake level. (Scot.) A water level driven from the surface to a point in a pumping shaft where the water is delivered. (Barrowman)

Offtake joint (Eng.). The joint by which the bucket is fastened to the rods. (Bainbridge)

Offtake rods (Eng.). Auxiliary wooden rods at the top and bottom of a winding shaft, by means of which the cages are guided and steadied during decking (Gresley). *See also* Offtake, 2.

Oficial de albañil (Sp.). A journeyman bricklayer. (Min. Jour.)

Oficial de carpintero (Sp.). A journeyman carpenter. (Min. Jour.)

Oficina. 1. (Sp.) An office. A work shop. 2. (Mex.) A furnace containing 12 or more clay retorts, six on each side, for reducing quicksilver ores. 3. (Chile) Nitrate works. 4. *O. de concentración*, concentration works; *O. de fundición*, smelting works; *O. de muestras*, sampling works. (Halse)

Ogie (Scot.). The space before the fire in a kiln. Called also Killogie. (Standard)

O'Hara furnace. A horizontal, double-hearth furnace for calcining sulphide ores. (Hofman, p. 186; Peters, p. 200)

Ohm. The practical unit of electrical resistance, being the resistance of a circuit in which a potential difference of one volt produces a current of one ampere. (Webster)

Ohm's law. The law that the strength or intensity of an unvarying electrical current is directly proportional to the electromotive force, and inversely proportional to the resistance of the circuit. The law does not hold for alternating currents unless modified so as to include the effects of counter electromotive force. (Webster)

Oido (Sp.). 1. Ear. 2. The orifice left in the tamping for the insertion of the fuse. (Halse)

Oikocryst. The matrix or larger crystal of a poikilitic fabric. (Iddings, Igneous Rocks, p. 202)

Oil. Any of a large class of unctuous combustible substances, which are liquid, or at least easily liquefiable on warming, and soluble in ether, but not in water. (Webster) This term includes: (a) fatty oils and acids; (b) essential oils, mostly of vegetal origin, such as encalyptus and turpentine, and (c) mineral oils, such as petroleum products, including lubricating oils. A term used in the flotation process. (Min. and Sci. Press)

Oil box. A box for oil, as for storage or lubrication. (Webster)

Oiler. 1. An oil which provides a film around a mineral particle (Megraw). A term used in flotation.
2. An oil well. 3. An oil can. 4. An engine-room greaser. (Webster)

Oil field. A district containing a subterranean store of petroleum of economic value. (Webster)

Oil flotation. A process in which oil is used in ore concentration by flotation. *See* Flotation process.

Oil car. 1. A box car with open side for carrying oil in barrels. 2. A platform car with tanks for carrying oil in bulk. Commonly called Tank car. (Century)

Oildag. Deflocculated graphite suspended in oil, used for lubricating. (Bacon)

Oil derrick. A towerlike frame used in boring oil wells, to support and operate the various tools. (Standard)

Oil fuel. Refined or crude petroleum, shale oil, grease, residuum tar, or similar substances, used as fuel. (Century)

Oil gage. An instrument of the hydrometer type arranged for testing the specific gravity of oils; an oleometer. (Century)

Oil gas. Illuminating gas, or heating gas, made by distilling oil in closed retorts. (Standard)

Oil-gas tars. Tars produced by 'cracking' oil vapors in the manufacture of oil gas. (Bacon)

Oil jack. A pitcher-shaped metal vessel for heating oil. (Standard)

Oil-line pump. A pump for forcing crude petroleum along a pipe line. (Standard)

Oil of paraffin. A colorless to yellowish, limpid oil, having a specific gravity of about 0.880 and not boiling below 360°. It is composed principally of high-boiling hydrocarbons of the C_nH_{2n+2} series, and is obtained from the petroleum fraction boiling above 300°, the product being refined and decolorized. It is used in pharmacy, in ointments, and as the base for various coatings insoluble in water. (Bacon)

Oil of talc. A nostrum of calcined talc, famous in the 17th century as a cosmetic. (Webster)

Oil of vitriol. Sulphuric acid.

Oil pits. *See* Hand-dug wells.

Oil pool. An accumulation of oil in sedimentary rock that yields petroleum on drilling. The oil occurs in the pores of the rock and is not a pool or pond in the ordinary sense of these words. (U. S. Geol. Surv., Bull. 613, p. 184)

Oil process. *See* Concentration, *also* Flotation process.

Oil pulp. An aluminum soap, consisting of aluminum salts of the fatty acids, chiefly oleic, palmitic, and stearic acids. It is dissolved in mineral oil to form an oil thickener. (Bacon)

Oil sand. Porous sandstone from which petroleum is obtained by drilled wells. (Webster)

Oil saver. An appliance affixed to the mouth of an oil well when the latter requires deepening, although still flowing in small quantities. It consists of a cap fitted to the top of the well casing and having a lateral pipe communicating with a reservoir for the oil. (Mitzakis)

Oil shale. Shale containing such a proportion of hydrocarbons as to be capable of yielding mineral oil on slow distillation (Gresley). *See* Shale, Shale oil, Pumpherston shale, Broxburn oil shale, Kerogen and Bituminous shales. (Bacon)

Oil smellers. Men who profess to be able to indicate where oil-bearing strata are to be found, and locate places for successful well boring, by the sense of smell.

Oil spring. A spring of petroleum, maltha, or other hydrocarbon, with or without admixture of water.

Oilstone. A fine-grained stone used for sharpening edged tools or other similar metal surfaces.

Oilstone powder. Pulverized oilstone used with oil for grinding and polishing metal surfaces. (Standard)

Oil-temper. To harden steel by chilling in oil after heating. (Webster)

Oil well. A dug or bored well, from which petroleum is obtained by pumping or by natural flow. (Raymond)

Oil-well packing. A packing inserted between the pipe and the interior surface of the boring in an oil well to keep surface water or water from the sides of the hole from running into the well, and to prevent oil in some wells from being forced out around the pipe by a pressure of gas. (Century)

Oily; greasy. These are substantially equivalent terms. All oils are greasy. Greasiness suggests more viscidity than oiliness. A term used in the flotation process. (Min. and Sci. Press)

Oil zone. A formation that contains capillary or supercapillary voids, or both, that are full of petroleum that will move under ordinary hydrostatic pressure. (Meinzer)

Ojal (Sp.). A loop tied to the rope of a hand winch, when used for raising and lowering men. (Halse)

Ojo (Sp.). 1. Eye. 2. A bunch of ore in a lode; a small irregular deposit 3. Mesh. 4. Peephole of a blast furnace. 5. *O. de agua*, a spring that spouts water (Halse). *O. de polvillo*, a spot of rich ore. (Min. Jour.)

Ojosa (Mex.). Honeycombed structure. (Dwight)

Okonite. 1. A compact fibrous calcium silicate, $H_2CaSi_2O_6+H_2O$. (Dana) 2. A vulcanized mixture of ozocerite and resin with caoutachouc and sulphur, used as an insulating material for electric conductors. (Century)

Old. Having reached the stage of decreasing vigor and efficiency of action or of increasing simplicity of form and reduction of relief: said of streams, and of land forms. (La Forge)

Old age. That stage in the development of streams, and land forms when the processes of erosion are decreasing in vigor and efficiency or the forms are tending toward simplicity and subdued relief. *Compare* Youth and Maturity. (La Forge)

Old man. 1. Ancient workings, goaves. (Raymond)
2. (Scot.) A rocking center to guide pump rods at an angle. (Barrowman)

Old men. The persons who worked a mine at any former period of which no record remains. (Raymond)

Old red sandstone. A thick group of reddish sandstone, conglomerates and shales, of nonmarine origin, which constitute the Devonian system in parts of Great Britain and are regarded as equivalent in age to the normal marine Devonian strata. In North America the name was formerly applied to rocks of the Catskill group, which display some striking analogies to the Old Red Sandstone of Europe. (La Forge)

Old sand. A molding-sand rendered friable and porous by frequent high heating. (Standard)

Old silver. Silver made to appear old by the application of graphite and grease. (Standard)

Old waste (Scot.). Old or abandoned workings. (Barrowman)

Olefiant gas. Ethylene, a colorless inflammable gaseous compound, C_2H_4, having a suffocating odor and contained in coal gas: bicarbureted hydrogen. (Standard)

Oleic acid. The fatty acid contained in olive-oil combined with cresoline. Although called 'acid,' it is an oily substance and functions as oil in flotation operations; it is contained in most mixed oils and fats, from which it is obtained by saponification with an alkali. From L. *oleum*, oil. (Rickard)

Olho (Braz.). 1. A vug or druse. 2. A bunch of ore. (Halse)

Oligist. A crystallized variety of hematite. Called also Oligist iron. (Webster)

Oligocene. The second of the epochs into which the Tertiary period is at present ordinarily divided. Also the series of strata deposited during that epoch. (La Forge)

Oligoclase. A variety of feldspar intermediate between albite and anorthite, but more nearly the composition of the former. (Dana)

Oligonite. A variety of siderite containing manganese carbonate. (Standard)

Oligon spar. Same as Oligonite.

Oligosiderite. A meteorite which is characterized by the presence of but a small amount of metallic iron. (Webster)

Olivenite. A basic copper arsenate, 4-$CuO.As_2O_5H_2O$ (Dana). Also called Wood copper.

Olive ore. *See* Olivenite.

Oliver continuous filter. A revolving drum prepared as a leaf-filtering surface and divided into compartments, each of which is connected to a vacuum pipe and to a pipe for admitting compressed air. The drum is partly immersed in a tank or box of thick pulp and revolves at a slow rate of speed. The vacuum causes ¼ to ½ in. slime cake to form; after emerging, the solution is sucked out of the adhering cake; a wash is then given and displaced by air as far as possible; and finally the cake is dropped by compressed air. (Liddell)

Olivine; Chrysolite; Peridot. An orthosilicate of iron and magnesium, $2(Mg.Fe)O.SiO_2$. Used as a gem. (U. S. Geol. Surv.) The name of the mineral is prefixed to the names of many rocks that contain it. Olivine is of especial importance in this respect, as its presence marks a more basic development in the rocks, which have it as contrasted with those which lack it. (Kemp)

Olivine diabase. A diabase containing olivine. (Standard)

Olivine gabbro. A gabbro containing olivine. (Standard)

Olivine norite. A variety of norite containing olivine. (Standard)

Olivinoid. An olivine-like substance found in meteorites. (Standard)

Olivinophyre. Porphyry containing olivine phenocrysts.

Olla. 1. (Sp.). A porous, earthen jar in which drinking water is cooled by evaporation from the outer surface; used in tropical countries (Standard.) 2. (Mex.) A slag pot. (Dwight)

Ollero. 1. (Mex.) A slag-pot puller. (Dwight). 2. A potter. (Halse)

Olletas. (Sp. Am.) Hollows in river beds. (Lucas)

Ollite. Potstone; a variety of impure soapstone.

Omnibus. In glass-making, a sheet-iron cover to protect from drafts the glass articles in a leer. (Standard)

Omphacite. A greenish, vitreous variety of pyroxene that is a common constituent of the garnet rock, eclogite. (Dana)

On air (Scot.). Said of a pump when air is drawn at each stroke. (Barrowman)

Oncosimeter. An instrument for determining the specific gravity of a molten metal by the immersion of a ball made of another metal and of known weight. (Standard)

Oncost. 1. (Scot.) All charges for labor in getting mineral other than the miners' wages; payment to the collier in addition to the rate per ton. (Barrowman)
2. (Scot.) Dead-work expenses, being costs incurred at a mine, whether minerals are raised or not. (Gresley)

Oncost-men (Scot.). All workmen, other than miners, paid by day's wages. (Barrowman). A company man.

One way (So. Staff.). A particular class of house coal. (Gresley)

One-track tipple. A tipple having but one railroad track beneath it. (Steel)

Onico; (or Onique (Sp.). Onyx. (Lucas)

Onicolo. A variety of onyx used in making cameos, being characterized by a bluish tinge, produced by a thin layer of white over the black. (Standard)

Onofrite. Sulpho-selenide of mercury, Hg(S,Se). Contains 81 to 82 per cent of mercury. (U. S. Geol. Surv.)

On plane (Scot.). In a direction at right angles to, or facing, the plane or main joints. (Barrowman)

Onsetter. The man who places cars on or takes them off the mine cage. *See* Bottomer; *also* Cager. (Gresley)

Onsetting machine (Eng.). A mechanical apparatus for loading cages with the full tubs and discharging the empties, or vice versa, at one operation. (Gresley)

On shift (Scot.). A workman or working place is said to be on shift, or on shift wages when the work is not let under contract, but paid for by day's wages. (Barrowman)

On sights. Following sights placed by a surveyor. (Steel)

On-the-run (Penn.). The ability to work a seam of coal that has sufficient inclination to cause the coal, as worked toward the rise, to fall by gravity to the gangways for loading into cars, is called working coal on-the-run. (Gresley)

On-the-solid. 1. Applied to a blast hole extending into the coal farther than the coal can be broken by the blast. 2. That part of a blast hole which can not be broken by the blast. (Steel)
3. A practice of blasting coal with heavy charges of explosives, in lieu of undercutting or channeling.

Onychite. An alabaster, or calcite (stalagmite), with yellow and brown veins, carved by the ancients into vases, etc. (Standard)

Onyx. A cryptocrystalline variety of quartz, made up of different colored layers, chiefly white, yellow, black, or red. Not found in commercial quantity in United States. (U. S. Geol. Surv.)

Onyx marble (including Mexican onyx). Calcite somewhat resembling true onyx in appearance and used as an ornamental stone. Is usually formed as stalactites, stalagmites, vein filling, or spring deposits. (U. S. Geol. Surv.)

Onza de oro (Sp.). A large gold coin struck during the nineteenth century by some of the South American republics, and by Spain in the latter part of the eighteenth century. It was worth about sixteen dollars. Also called Doblon; Doubloon. (Century)

Oölite. 1. A variety of limestone consisting of round grains like the roe of a fish. The name is derived from two Greek words, which mean, "Egg-stone." (Thompson)

2. The upper part of the Jurassic system in England and some other parts of Europe. (Webster)

Oölitic. Characteristic of, pertaining to, of the nature or texture of, or composed of oölite. (La Forge)

Oolly (E. Ind.). A lump of steel, as Wootz steel when removed from the crucible. (Standard)

Ooze; Oaze. 1. A soft slimy, sticky mud. (Power)
2. To exude or give out slowly. (Webster)

Opacite. A noncommittal term, less current than formerly, for microscopic, opaque grains observed in thin sections of rocks. They are generally regarded today as chiefly magnetite dust. (Kemp)

Opal. Hydrous silica, SiO_2+H_2O. When it shows a play of colors, or opalescence, it becomes the gem stone or precious opal of commerce, known as 'fire opal.' (U. S. Geol. Surv.)

Opalescence. A milky or pearly reflection from the interior of a mineral. (Dana)

Opalescent. Resembling opal. (Winchell)

Opaline. In glass making, a translucent, milky variety of glass; fusible porcelain; milky glass. Called also Hot-cast procelain. (Standard)

Opalized wood. Wood petrified by siliceous earth, and acquring a structure similar to the simple mineral called opal (Comstock). *See* Wood, 2.

Opal jasper. Common opal with the color of yellow jasper. (Chester)

Ópalo (Sp.). Opal; *O. de fuego*, fire opal; *O. nobles*, precious opals. (Halse)

Opencast. 1. A working in which excavation is performed from the surface, as in quarrying. 2. Exposed to the air like a quarry; as *opencast* working; a deposit worked *opencast* (Webster). Commonly called Open-cut; Open-pit.

Open connected. Applied to dredges in which a link is interposed between the buckets. (Weatherbe)

Open-crib timbering. Shaft timbering with cribs alone, placed at intervals. (Raymond)

Open-cut. 1. (Eng.) To drive headings out, or commence working in the coal, etc., after sinking the shafts. (Gresley)
2. (Scot.). To commence longwall working. (Barrowman)
3. To increase the size of a shaft when it intersects 'drift' so as to form a puddle wall behind the sets of timber. (Duryee)
4. A surface working, open to daylight (Raymond). Also called Opencast; Open-pit.

Open-cut system. *See* Overhand stoping; Stripping.

Open fault. *See* Fault.

Open-front. The arrangement of a blast furnace with a fore-hearth. (Raymond)

Open-hearth. *See* Furnace. The form of regenerative furnace of the reverberatory type used in making steel by the Martin, Siemens, and Siemens-Martin processes. (Century)

Open-hearth process. A process for manufacturing steel, either acid or basic, according to the lining of the reverberatory furnace, in which selected pig iron and malleable scrap iron are melted, with the addition of pure iron ore. The latter, together with the air contributes to the oxidation of the silicon and carbon in the melted mass. The final deoxidation is sometimes produced by the addition of a small quantity of aluminum or of ferromanganese, which at the same time desulphurizes and recarburizes the metal to the required extent. (Goesel)

Open hole. Coal or other mine workings at the surface or outcrop (Gresley). Also called Opencast; Open-cut; Open-pit.

Opening. 1. A widening out of a crevice, in consequence of a softening or decomposition of the adjacent rock, so as to leave a vacant space of considerable width. (Century)
2. A short heading driven between two or more parallel headings or levels for ventilation. (Gresley)
3. An entrance to a mine.

Openings. The parts of coal mines between the pillars, or the pillars and ribs. (Raymond)

Opening shot. In shooting off the solid, the first shot fired in a straight face of coal. Called also Wedging shot or Gouging shot.

Open light. A naked light (Gresley). Not a safety light.

Open mold. A mold without cover, in which objects like ingots are cast: distinguished from Close mold. (Standard)

Open-off. 1. (Eng.) To begin the longwall system from the shaft pillar, or the far end of the royalty, or from any headings previously driven out for the purpose of commencing such system. (Gresley)
2. To start any new working, as a heading, entry, gangway, room, etc., from another working, as a slope, gangway, etc.

Open pit mine. *See* Open-cut, *also* Opencast.

Open-pit quarry. A quarry in which the opening is the full size of the excavation. One open to daylight. (Bowles)

Open rock. Any stratum capable of holding much water, or conveying it along its bed by virtue of its porous or open character. (Gresley)

Opens. Large caverns. (Raymond)

Open-sand castings. Castings made in molds simply excavated in sand, without flasks. (Raymond)

Open sand-mold. A process of founding without any cope or top to the mold: used for heavy objects. (Standard)

Openset (Scot.). An unfilled space between pack walls. (Barrowman). *See also* Cundy.

Open-shell auger (Eng.). A coal-boring tool for extracting clay and other débris from the hole. (Gresley)

Open shop. A shop, or mine, where the union price is paid, but where the workmen are not all union men.

Open-stope and filling. *See* Overhand stoping.

Open-stope method. *See* Overhand stoping.

Open-top tubbing. A length of tubbing having no wedging crib on the top of it. (Gresley)

Open-work. 1. A mine working that is open to the sky; an opencast. (Webster)
2. (So. Staff.) A coal quarry (Min. Jour.). *Also* Open; Open-pit; Open-cut.

Open-working. Surface mining; quarrying; open-pit mining.

Operario (Mex.). A working miner. (Dwight)

Operator. (Penn.) The person, whether proprietor or lessee, actually operating a mine. (Raymond)

Ophicalcite. A crystalline limestone, spotted with serpentine. (Kemp).

Ophiolite. Brogniart's name for the serpentines. It is also employed in America in the sense of ophicalcite as above given. (Kemp)

Ophite. 1. A name given in 1798 by the Abbé Palassou to a green rock of the Pyrenees. It was later recognized to be composed of feldspar and hornblende, and still later was determined by Zirkel to be a uralitized diabase. The name has chief significance today because used to describe the textural peculiarity of some diabases. Strictly speaking an ophitic texture is one in which rod-like or lath-shaped, automorphic plagioclase feldspars are involved in augite, as it were, in a paste, so as to form a variety of poicilitic texture. (Kemp)
2. A variety of marble colored green by serpentine. Called also Verd antique. *See also* Ophicalcite. (Standard)

Ophitic. Having earlier-formed euhedral crystals of labradorite surrounded by later-formed crystals of augite: said of the texture of some diabases. (La Forge)

Optical character. The designation as to whether optically positive or optically negative (A. F. Rogers). Said of minerals.

Optical constants. In optical mineralogy, the indices of refraction, axial angle, extinction angle, etc. (A. F. Rogers)

Optic angle. In a biaxial crystal, the angle between the optic axes. (Standard)

Optic axes. Those directions in anisotropic crystals along which there is no double refraction. (Dana)

Option. A privilege secured by the payment of a certain consideration for the purchase, or lease, of mining or other property, within a specified time, or upon the fulfilment of certain conditions set forth in the contract.

Opus incertum. Masonry of small stones set irregularly in mortar. (Standard)

Opus lateritium. Brickwork or tilework in horizontal courses with broken joints. (Standard)

Opus reticulatum. Recticulated masonry. (Standard)

Opus tessellatum. Mosaic composed of small cubes of marble, glass, or clay. (Standard)

Orange sand. A deposit of sand, gravel, and pebbles, containing bowlders of northern Paleozoic rocks, occurring in the Mississippi valley: a diluvial deposit of the Champlain or quarternary epoch. (Standard)

Orang gulla (Sumatra). Miners. (Lock)

Orangite. A bright, orange-yellow variety of thorite (Chester). *See* Thorite, 1.

Orbicular. Containing spheroidal aggregates of megascopic crystals, generally in concentric shells composed of two or more of the constituent minerals: said of the structure of some granular igneous rocks, as corsite. (La Forge) *See* Kugel, *also* Spheroidal. (Kemp)

***Orbicular* granite.** A granite containing numerous rounded segregations of minerals, chiefly dark silicates. (Ries)

Orbite. A name proposed by Chelius for certain diorite dikes near Orbeshöhe, Hesse, of porphyritic texture and having large phenocrysts of hornblende, biotite and plagioclase. (Kemp)

Orchard-heating oil. A dark oil from California petroleum, possessing a gravity of 26° to 28° Bé.; it is also termed smudge oil, and is used in the orange and lemon groves to prevent frost from injuring the trees. (Bacon)

Ordenanzas de mineria (Mex.). The *O. de Mineria*, or Mining Ordinances, came into operation in Mexico in 1784, and were replaced by the (first) Código de Minas in 1884. (Halse)

Ordinarios (Mex.). Low-grade ores. (Dwight)

Ordinary ray. That ray of polarized light which, in a doubly refracting medium, follows the usual law as to the constant ratio between the sines of the angles of incidence and refraction. (Dana)

Ordovician. The second of the periods comprised in the Paleozoic era, in the geologcal classification now generally used. Also the system of strata deposited during that period. (La Forge)

Ore. 1. A natural mineral compound, of the elements of which one at least is a metal. The term is applied more loosely to all metalliferous rock, though it contain the metal in a free state, and occasionally to the compounds of non-metallic substances, as sulphur ore (Raymond). Also, material mined and worked for nonmetals, as pyrite is an *ore* of sulphur (Webster)

A mineral of sufficient value as to quality and quantity which may be mined with *profit*. (Ihlseng)

A mineral, or mineral aggregate, containing precious or useful metals or metalloids, and which occurs in such quantity, grade, and chemical combination as to make extraction commercially *profitable*. (Robert Peele, Min. and Met. Soc. of America, *Bull.* 64, p. 257)

A metalliferous mineral, or an aggregate of metalliferous minerals, more or less mixed with gangue, which from the standpoint of the miner, can be won at a profit, or from the standpoint of a metallurgist can be treated at a profit. The test of yielding a metal or metals *at a profit* seems to me, in the last analysis, to be the only feasible one to employ. (J. F. Kemp, *Trans.*, Canadian Min. Inst., 1909, p. 367)

2. (Corn.). Copper ore; tin ore being spoken of in Cornwall as tin.

(Joplin, Mo.) A lead, zinc, or lead-zinc concentrate obtained from milling. The crude ore is called *dirt*.

3. In metallurgy, a soft but compact variety of hematite used for the bottom of puddling furnaces. (Webster)

Oreala (Sp.). A kind of clay used in the manufacture of pottery in British Guiana. (Standard)

Ore bands. Zones of rock rich in ore, occurring in belts of fahlbänder. (Power)

Ore beds. Metalliferous aggregations occurring between (or in) rocks of sedimentary origin. (Power)

Ore bins. Receptacles for ore awaiting treatment or shipment.

Ore blocked out. Ore exposed on three sides within a reasonable distance of each other. (H. C. Hoover, p. 17)

Ore body. Generally a solid and fairly continuous mass of ore, which may include low-grade and waste as well as *pay ore*, but is individualized by form or character from adjoining country rock.

Ore-bridge. A large electric gantry-type of crane which, by means of a clamshell bucket, stocks ore or carries it from the stock pile into bins or larry car on trestle. (Willcox)

Ore-bridge bucket. A clamshell grab bucket of 5 to 7½ tons capacty. (Willcox)

Ore car. A mine car for carrying ore or waste rock. (Weed)

Ore channel. The space between the walls or boundaries of a lode which is occupied by ore and veinstone (Power). Also called Lode country.

Ore chute. An opening in ore or rock through which ore is dropped downward, and frequently used for ore bins and pockets, underground. A trough or lip at the bottom of a bin for conveying ore to a car, conveyor, etc.

Ore crusher. A machine for breaking up masses of ore, usually previous to passing through stamps or rolls.

Ore currents. Aqueous solutions of metalliferous minerals, circulating through the earth's crust.

Ore delfe. 1. Ore lying underground. 2. Right or claim to ore from ownership of land in which it i found. (Century)

Ore developed. Ore exposed on four sides in blocks variously prescribed. *See* Positive ore, *also* Proved ore. (H. C. Hoover, p. 17)

Ore developing. Ore exposed on two sides. *See* Probable ore. (H. C. Hoover, p. 17) First class, blocks with one side hidden; second class, blocks with two sides hidden; third class, blocks with three sides hidden. (Philip Argall, Min. and Met. Soc. of Am., Bull. 64, p. 260)

Ore district. A combination of several ore deposits into one common whole or system. (Power)

Ore drag (Corn.). A drag made of green oxhides for bringing ore down the mountains on snow. The ore is sewed up in sacks of 100 pounds each, then placed on the hide, which has loops around the edge, and when the desired number of sacks are in position a rope is run through the loops and drawn taut, with the hair of the skin outwards. (Crufutt)

Ore-dressing. The cleaning of ore by the removal of certain valueless portions as by jigging, cobbing, vanning, and the like. *See* Concentration.

Ore dump. A heap or pile of ore at the tunnel or adit mouth, the top of shaft, or other place. (Weed)

Ore expectant. The whole or any part of the ore below the lowest level or beyond the range of vision. *See* Possible ore, *also* Prospective ore (H. C. Hoover, p. 17). The prospective value of a mine beyond or below the last visible ore, based on the fullest possible data from the mine being examined, and from the characteristics of the mining district. (Philip Argall, Min. and Met. Soc. of Am., Bull. 64, p. 260)

Ore faces. Those ore bodies that are exposed on one side, or show only one face, and of which the values can be determined only in a prospective manner, as deduced from the general condition of the mine or prospect. (Min. and Met. Soc. of Am., Bull. 64, p. 259)

Oregon sledge. A broad-faced sledge hammer. (Willcox.)

Ore-hearth. 1. A small, low fireplace surrounded by three walls, with a tuyère at the back. Three important types are: (*a*) Scotch ore-hearth, (*b*) American water-back ore-hearth, and (*c*) Moffet ore-hearth, used in smelting. (Hofman, p. 117)
2. (Eng. and Scot.) A small blast furnace for smelting lead; a blast hearth. (Standard)

Ore-hearth process. A process for the extracton of lead in which lead ore, mixed with fuel, is treated on a roasting hearth.

Orei. A quarry term applied to granite that has been rendered valueless by the alteration of its aegirite particles. (Perkins)

Ore in sight. A term frequently used to indicate two separate factors in an estimate, namely: (*a*) Ore blocked out, that is, ore exposed on at least three sides within reasonable distance of each other; (*b*) Ore which may be reasonably assumed to exist, though not actually blocked out; these two factors should in all cases be kept distinct, because (*a*) is governed by fixed rules, while (*b*) is dependent upon individual judgment and local experience. The expression "ore in

sight" as commonly used in the past, appears to possess so indefinite a meaning as to discredit its use completely. The terms Positive ore, Probable ore, and Possible ore are suggested. (Min. and Met. Soc. of Am., Bull. 64, pp. 258 and 261)

Ore leave. The value of the right to dig and take ore; also, the value of ore in place. (Coleman's Appeal, 62 Pennsylvania, State, p. 279)

Ore mill. A stamp mill; a concentrator.

Orendite. An aphanophyric igneous rock containing small phenocrysts of phlogopite in a groundmass composed essentally of leucite, sanidine, diopside, and phlogopite. (La Forge) The name was proposed by Whitman Cross, for the peculiar leucitic rocks at Orenda Butte in the Leucite Hills, Wyo. They contain leucite and sanidine, in about equal amounts, with phlogopite and diopside as essentials. A peculiar amphibole is also present. The rock is a leucite-phonolite as the latter term is used by older writers, but the objection to calling any rock a phonolite which lacks nephelite, led to the name orendite. *Compare* Madupite and Wyomingite. (Kemp)

Ore partly blocked. Those ore bodies that are only partly developed, and the values of which can be only approximately determined. (Min. and Met. Soc. of Am., Bull. 64, p. 259) *See* Probable ore.

Ore plot. A place where the dressed ore is kept. (Davies)

Ore pocket. An isolated and limited deposit of rich ore. (Standard)

Ore process. In steel making the Siemens process. *See* Open-hearth.

Ore reserve. *See* Reserve.

Ore separator. A cradle, frame, jigging-machine, washer, or other device or machine used in separating the metal from broken ore, or ore from worthless rock. (Standard)

Oreshoot. A large and usually rich aggregation of mineral in a vein. It is a more or less vertical zone or chimney of rich vein matter extending from wall to wall, and has a definite width laterally. Sometimes called Pay streak, although the latter applies more specifically to placers.

Ore stamp. A machine for reducing ores by stamping. The most familiar form is the stamp battery, and the latest the powerful steam stamp. (Standard)

Ore washer. A machine for washing clay and earths out of earthy brown-hematite ores (Raymond). The log washer is a common type.

Ore zone. A large deposit of ores or minerals in place (Duryee). *See* Zone, 2; Mineralized zone, and Vein.

Organale (Colom.). An alluvial deposit intercalated between stones or bowlders, rendering it difficult and dangerous to work. (Halse)

Organic. 1. In chemistry, pertaining to or designating a branch of chemistry treating in general of the compounds produced in plants and animals, and of many carbon compounds of artificial origin; contrasted with inorganic. (Webster)
2. Having organs for carrying on vital processes. Animals and plants are thus organized as distinguished from minerals or inorganic substances. When these organs or organic structures become mineralized they are fossils, or organic remains. (Roy. Com.)

Organic deposits. Rocks and other deposits formed by organisms or their remains. (A. F. Rogers)

Organpipe coral. A tubiporoid coral consisting of cylindrical tubes placed side by side and united by horizontal floorlike expansions. (Standard)

Orichalc. Under the Roman empire, an alloy of copper and zinc, resembling gold in appearance; brass. There was also a white orichalc. (Standard)

Orichalceous. Having a color between gold and brass; of, or pertaining to, orichalc. (Standard)

Oriental. 1. Frequently used in the same sense as 'precious' when applied to minerals, from an old idea that gems came principally from the East, *e. g.*, Oriental amethyst, Oriental chrysolite, Oriental emerald, Oriental topaz, all of which are varieties of sapphire. (Power)
2. Specially bright, clear, pure, and precious; said of gems. (Standard)

Oriental agate. Understood to be all the most beautiful and translucent sorts of agate. (Power)

Oriental amethyst. Strictly speaking, a variety of sapphire, but the term is applied to any amethyst of exceptional beauty. (Power)

Oriental emerald. A green variety of corundum. (A. F. Rogers)

Oriental garnet. Precious garnet. (Webster)

Oriental powder. An explosive consisting of a mixture of gamboge with potassium nitrate and chlorate. (Webster)

Oriental ruby. The true ruby, a variety of corundum. (A. F. Rogers)

Oriental sapphire. The true sapphire, a variety of corundum. (A. F. Rogers)

Oriental topaz. A yellow variety of corundum, Al_2O_3. (Dana)

Orientation. 1. In surveying, the rotation of a map (or instrument) until the line of direction between any two of its points is parallel to the corresponding direction in nature. (Webster). 2. The placing of a crystal in the conventional attitude, so as to show its symmetry and the forms to which its faces belong. (La Forge)

Oriente (Sp.). East. (Dwight)

Origin. The source or ground of the existence of anything, either as cause or as occasion; that from which a thing is derived or by which it is caused; especially that which initiates or lays the foundation (Standard). As *Origin* of Ore deposits.

Original. Charistic of or existing in a rock at the time of its formation: said of minerals, textures, etc., of rocks; essentially the same as Primary 1, and contrasted with Derived or Secondary 1. (La Forge)

Orin (Sp.). Iron rust. (Lucas)

Oriskany sandstone. A sandstone occurring in the Devonian age in the United States.

Orito (Colom.). A trace of gold found in the *batea*. (Halse)

Ormolu. 1. An alloy of copper, zinc, and tin used for cheap jewelry, chandeliers, etc. 2. Leaf gold ground and used as a pigment for bronzes, brasses, or other objects to be gilded. (Standard)

Ornamental brick. A somewhat broad term applied to front brick, that are either of some form other than that of a rectangular prism or, that have the surface ornamented with some form of design. (Ries)

Ornoite. A dioritic rock from the Swedish locality of Ornö. It contains prevailing oligoclase, with some hornblende and very subordinate microcline and orthoclase. The accessories are apatite, magnetite, pyrite, titanite, and a little prehnite. The name was given by A. Cederstrom. (Kemp)

Oro (Sp.). Gold; *O. bajo*, low-grade ore; *O. corrido*, alluvial gold; *O. crespo*, gold found at a distance from the main deposit; *O. cristalizado*, crystallized gold; *O. de aluvión*, placer gold (Lucas); *O. de copela*, fine gold (Min. Jour.); *O. de corte*, gold extracted from large placer workings (Lucas); *O. de escama*, spangle gold; *O. de espuma*, float gold; *O. de lavadero*, wash gold; *O. de ley*, high-grade gold; *O. de molino*, gold obtained by milling; *O. de monte*, gold found at a distance from the main deposit; *O. de recogida*, gold from various mines; *O. de veta*, lode gold; *O. empolvado*, gold dust (Min. Jour.); *O. en hojas*, leaf gold; *O. fino*, fine gold; *O. libre*, free gold; *O. molido á mano*, gold obtained by hand crushing; *O. nino*, float gold; *O. verde*, green gold. (Lucas)

Oroche (Mex.). 1. Low-grade or yellowish silver. 2. Bullion containing gold and silver. Doré (Dwight). 3. *O. natural*, native auriferous silver. (Halse)

Orogeny. The process of mountain building. (Webster)

Orography; Orology. That branch of physical geography which treats of mountains and mountain systems. (Webster)

Oroide. An alloy, chiefly of copper and zinc, or tin, resembling gold in color and brilliancy, and used in making cheap jewelry. (Webster)

Orology. *See* Orography.

Orometer. A form of aneroid barometer.

Oronite. An enamel paint for protecting metal surfaces from the action of hot vapors.

Orpailleur (Fr.). A gold washer. (Davies)

Orpiment. Arsenic trisulphide, As_2S_3, containing 61 per cent arsenic. (Dana)

Orrillaje (Mex.). Sheet lagging. (Dwight)

Orthite. *See* Allanite.

Ortho axis; Orthodiagonal. In the monoclinic system, the axis that is perpendicular to the other two axes. (La Forge)

Orthoclase. The monoclinic potash feldspar, $K_2O.Al_2O_3.6SiO_2$. Contains 16.9 per cent potash, K_2O. *See* Feldspar (U. S. Geol. Surv.).

Orthoclastic. Cleaving in directions at right angles to each other. (Webster)

Orthodome. In the monoclinc crystallographic system, a dome parallel to the orthoaxis. (La Forge)

Orthofelsite. A name suggested by J. J. H. Teall for porphyritic rocks with felsitic groundmass, and phenocrysts of orthoclase. (Kemp)

Orthogneiss. 1. A gneiss formed by the metamorphism of an igneous rock. 2. A gneissic igneous rock whose structure is original and is due to flowbanding or to segregation while the rock was solidifying. (La Forge)

Orthophyre. Orthoclase porphyry or porphyry proper (Kemp). Syenite porphyry. (Standard)

Orthopinacoid; Orthopinacoidal. The pinacoid parallel to the orthodiagonal. (Standard)

Orthoprism. A monoclinic prism whose orthodiagonal intercept is greater than unity. (Standard)

Orthorhombic system. In crystallography, that system of crystals whose forms are referred to three unequal mutually perpendicular axes; also called Prismatic, Rhombic, and Trimetric.

Orthosilicate. A salt of orthosilicic acid: applied to minerals. Called also Unisilicate. (Standard)

Orthosilicic acid. A compound, H_4SiO_4, known chiefly by its salts found in minerals. (Standard)

Orthose. A name for the whole feldspar family (1801), before it was divided into separate species. (Chester)

Orthotomous. Having the two cleavages at right angles to each other (Standard). Same as Orthoclastic.

Oryctogeology. The classification and arrangement of fossils. (Standard)

Oryctognosy. The description and systemmatic arrangement of minerals; mineralogy. (Century)

Oryctology. The science of fossils or whatever is dug from the earth; now separated into paleontology, geology, petrology, and mineralogy. (Standard)

Os. A Swedish term, equivalent to *esker*, for certain elongated ridges of detrital material, generally explained as having been deposited in subglacial tunnels. (Century)

Oscillatory twinning. Repeated twinning in which the crystal is made up of thin lamellae alternately in reversed position; polysynthetic twinning: found in some feldspars. (La Forge)

Osmium. A hard, bluish or grayish-white metallic element of the platinum group, the heaviest substance known. Symbol, Os; atomic weight, 190.9; specific gravity 22.48.

Osmond (Osmund) iron. A superior kind of iron formerly imported into England from Sweden for making arrow heads, fishhooks, clocks, etc. Also iron made in the Osmund furnace. (Webster)

Osmondite. A solid solution of iron carbide in alpha iron. (Webster)

Osmose. The tendency of two liquids or gases to mix by passing through a membrane or porous wall separating them. From Gr. *osmos*, pushing. (Rickard)

Osmosis. A kind of diffusion which takes place between two miscible fluids separated by a permeable partition, as an animal membrane and which tends to equalization on the two sides of the partition (Webster)

Osmotic. Of or pertaining to osmosis.

Osmotic equivalent. The ratio between the amount of solvent water that passes through the membrane or septum of an osmotic cell and the amount of solute which passes in the opposite direction. (Webster)

Osmotic pressure. The unbalanced pressure which gives rise to the phenomena of diffusion and of osmosis, as in a solution in which there are differences of concentration. (Webster)

Osmund furnace. A kind of high forge, intermediate in the development of the Catalan forge and the blast furnace formerly used for making wrought iron from which wire was first made in England, in the 15th century. (Webster)

Osseous breccia. The cemented mass of fragments of bones of extinct animals, found in caverns and fissures. (Comstock)

Ossipyte. A name suggested by C. H. Hitchcock for a rock from Waterville, N. H., which on examination in 1871 by E. S. Dana (before the use of thin sections in America) was thought to consist of olivine and labradorite, with a little magnetite. Ossipyte is derived from "Ossipees," the name of a tribe of Indians, who formerly lived in the region. By means of thin sections the rock was later shown to contain diallage, by G. W. Hawes, and to be a gabbro. Ossipyte was a forerunner of troctolite over which it has priority. (Kemp)

Ostatki. The residuum in the still after the distillation of the kerosene from Russian petroleum. It is a thin liquid of a specific gravity of about 0.905 to 0.912; contains but little paraffin, yields lubricating oils, the remainder being utilized for fuel. (Bacon)

Osteolite. Earthy apatite. (Dana)

Ostler. The person who feeds the mine horses or mules and keeps the stable in order (Roy). A contraction of hostler.

Ostwald's dilution law. The law, that in a solution of an electrolyte, the square of the number of moles ionized, divided by the number of moles not ionized varies directly as the dilution. (Webster)

Otavite. (S. W. Afr.). A white to reddish basic carbonate of cadmium occurring in lustrous crystalline crusts. (Webster)

Ottrelite. A gray to green, hard, brittle micaceous silicate, resembling chloritoid, of doubtful composition and uncertain crystallization. (Standard)

Ottrélite schists. Schistose rocks with the peculiar micaceous mineral ottrelite. They are best known from the Ardennes, Belgium, but are found in New England. (Kemp)

Ouachitite (pronounced waw-shee-tite). A name coined by Kemp from the Ouachita River, Arkansas for a basic rock containing, in a glassy groundmass, prevailing and often phenomientally large phenocrysts of biotite, very subordinate augite, and magnetite. They also occur at Beemerville, N. J., associated with nephelite-syenite. (Kemp)

Ouges (Eng.). The solid rock on the side of the vein. (Bainbridge)

Oulopholite. A variety of gypsum found in the form of rosettes, flowers, vines, etc., in Mammoth cave, Kentucky. (Standard)

Ounce. One-sixteenth part of an avoirdupois pound of 7,000 grains; that is, 437.5 grains. It equals 18.23 pennyweights, 0.911 troy ounce, 28.35 grams, and has a fine-gold value of $18.84 or 77.474 shillings.

Outbond. Laid parallel to the face of the wall; said of a brick, and opposed to Inbond. (Standard)

Outbreak coal (Eng.). An old term for outcrop of a coal seam. (Gresley)

Outburst. 1. A blower. A sudden emission of large quantities of occluded gas. (Steel)
2. (Scot.) *See* Outcrop, 1 and 2.

Outby; Outbye; Outbyeside. (Newc.). Nearer to the shaft, and hence further from the working face (Raymond). Toward the mine entrance. The opposite of Inby.

Outcrop. 1. The coming out of a stratum to the surface of the ground. That part of a stratum which appears at the surface; basset. 2. To crop out; to come out to the surface of the ground, as strata (Webster) A term used in connection with a vein or lode as an essential part of the definition of apex, which *see*. It does not necessarily imply the visible presentation of the mineral on the surface of the earth, but includes those deposits that are so near to the surface as to be found easily by digging. (Stevens *v.* Williams, 1 McCrary, p. 480; 23 Federal Cas., p. 40; 1 Mo. Min., p. 566; Sloss-Sheffield Steel & Iron Co. *v.* Payne, 64 Southern, 617)

Outdoor stroke. That stroke of a Cornish pumping engine by which the water is forced upward by the weight of the descending pump rods, etc. (Gresley)

Outfall (Eng.). A seam cropping out at a lower level. (Gresley)

Outlay. 1. A laying out or expending. 2. That which is expended; expenditure (Webster). The cost of equipping a mine and placing it on a producing basis.

Outlet. The passage by which the ventilating current goes out of a mine. Same as Upcast, 1 (Raymond). An opening from a mine to the surface.

Outlier. An isolated mass or detached remnant of younger rocks, or of rocks overthrust upon others, separated by erosion from the main mass to which they belong and now surrounded, areally, by older, or at least underlying, rocks. (La Forge)

Out of the house (Newc.). The downstroke of a pumping engine. (Min. Jour.)

Out-over. Same as Outby.

Output. The amount of coal or ore put out from one or more mines, or the total product of one or more furnaces or mills, during a given time. (Webster). *See also* Production.

Outset. 1. (No. of Eng.) The wall of a shaft built above the original ground level. 2. A brick or stone shaft-wall built within tubbing. (Gresley)

Outstroke (Eng.). The privilege of breaking a barrier, and working and conveying underground the coal from an adjoining royalty, or mine. (Gresley)

Outstroke rent (Eng.). Payment made for the privilege of working through a barrier and mining the coal of an adjoining property. (Gresley)

Outtake. The passage by which the ventilating current is taken out of the mine; the upcast (Chance). The return air course. An outlet.

Outwan (Scot.). Outwards. (Barrowman)

Outwash. Drift carried by running water from a glacier and deposited beyond the marginal moraine. (Webster)

Ouvarovite. *See* Uvarovite.

Oven. A chamber in which substances are artificially heated for the purposes of baking, roasting, annealing, etc. Specifically: 1. A kiln; as, a coke-*oven*. 2. In glass-making, a leer. (Standard)

Overall efficiency. Overall efficiency, of an air compressor, is the product of the compression efficiency and the mechanical efficiency. (A. I. M. E., Bull. 140, p. 57)

Overblown. Burnt by reason of an excessive blast; said of steel made by the Bessemer process. (Standard)

Overburden. 1. (Corn.) *See* Burden, 1. 2. To charge in a furnace too much ore and flux in proportion to the amount of fuel. 3. The waste which overlies the good stone in a quarry (Raymond). Worthless surface material covering a body of useful mineral. (Skinner)

Overcast. A passage through which the ventilating current is conveyed over an entry or air course. (Hargis)

Overcrossing. *See* Air crossing; Overcast.

Overdraft. An arrangement of flues to force air through a brick-kiln downward from its top; also the heated air and gas so forced through the kiln. (Standard)

Overfired. In creamics, exposed to too great heat in firing. (Century)

Overfold. An anticlinal fold pushed over until its sides are brought together and one overlies the other; an inverted or reflexed fold (Standard). *See* Overthrow fold.

Overgate. *See* Air crossing; Overcast.

Overgettings (Eng.). Minerals worked and sold from a royalty in excess of the certain quantity upon which a rent or royalty per acre is paid. (Gresley)

Overglaze. An additional glaze on porcelain when the first has been painted upon with vitrifiable colors, or when by reason of defects a second glaze is necessary. (Standard)

Overhand stoping. The working of a block of ore from a lower level to a level above. In a restricted way overhand stoping can be applied to open or waste-filled stopes that are excavated in a series of horizontal slices either sequentially or simultaneously from the bottom of a block to its top. Stull timbering or the use of pillars characterize the method. Filling is used in many instances (Young). Modifications are known as: Back-filling method; Back stoping; Block system; Breast stoping; Combined side and long-

wall stoping; Crosscut method of working; Cross stoping; Delprat method; Drywall method; Filling system; Filling-up method; Flat-back stoping; Horizontal slicing; Longwell stoping; Open-cut system; Open stope and filling; Open-stope method; Open stope, timbering with pigsties, and filling; Overhand stoping on waste; Resuing; Rock filling; Room-and-pillar with waste filling; Sawtooth back-stoping; Side stoping; Slicing and filling system; Stoping and filling; Stoping in horizontal layers; and Transverse with filling.

Overhand stoping and milling system. *See* Combined and underhand stoping.

Overhand stoping in inclined floors. *See* Rill stoping.

Overhand stoping on waste. *See* Overhand stoping.

Overhand stoping with shrinkage and simultaneous caving. *See* Combined shrinkage stoping and block caving.

Overhead cableway. A type of equipment for the removal of soil or rock. It consists of a strong overhead cable, usually attached to towers at either end, and on which a car or traveler may run back and forth. From this car a pan or bucket may be lowered to the surface and subsequently raised and locked to the car and transported to any position on the cable where it is desired to dump its contents. (Bowles)

Overhead charges. Those general charges or expenses which can not be charged up as belonging exclusively to any particular part of the work or product. (Webster)

Overings (Newc.). The top framing of a wagon to increase its capacity. (Min. Jour.)

Overlap. The extension of younger strata beyond the limits of older ones lying beneath. (Webster)

Overlap fault. *See* Fault.

Overlay (Scot.). The material above the rock in a quarry (Barrowman). *See* Overburden, 3.

Overlooker. 1. One who overlooks. 2. An overseer, superintendent, or inspector. (Standard)

Overman. (Eng.) The mining official next in rank below the manager, who is next below the agent (Raymond). Also called Oversman. The foreman of the underground workings.

Overpoled. A term used in copper refining to designate copper which has set from the molten condition with a distinct convex crown. *See* Undeveloped; *also* Tough pitch (Eng. and Min. Jour., vol. 102, p. 875). Overpoled copper is copper from which all the suboxide has been removed by poling. (Raymond)

Overrope. A winding or hoisting rope. (Gresley)

Overshot wheel. A vertical water wheel, the circumference of which is covered with cavities or buckets, and is turned by water that shoots over the top, filling the bucket on the farther side and acting chiefly by its weight. (Webster)

Overside. Discharging over the side; said of a dredge. (Standard)

Oversize. That part of a crushed material which remains on a screen.

Overstrom table. Similar to a Wilfley table but of diamond shape (rhomboid). (Liddell)

Over-throw. 1. (Penn.) Wooden air pipes for connecting headings for ventilation. 2. (York.) *See* Air crossing. (Gresley)

Overthrow fold. *See* Overturned.

Overthrust. The lateral thrusting of a mass of rock over or upon other rocks, along a thrust fault. (La Forge)

Overthrust fault. A reverse fault with low dip, or large hade. (Lindgren, p. 128)

Overturned. Having been tilted past the vertical and hence inverted in outcrop: said of folded strata and of the folds themselves. (La Forge)

Over ventilation. Too much air in the mine workings. (Gresley)

Overwash drift. The material which is washed out from the front of a glacier. (Century)

Overweight. 1. (Aust.) The settling down of the upper rocks when working by the longwall system. It is regulated by the packwalls. If it settles too quickly, it binds the underweight, causing the latter to throw too much weight on the face. (Power)
2. (Scot.) Excess weight of disposals (sales) over output. (Barrowman)

Overwind. To hoist the cage into or over the top of the headframe. (Steel)

Ovoca classifier. A classifier of the free-settling type in which the heavy material is removed by a double-screw, continuous-flight conveyor, working up an inclined plane. (Liddell)

Owen process. A flotation process involving the violent agitation of the pulp in cold water to which a small percentage of eucalyptus oil, about 2 ozs. per ton, is added. (T. J. Hoover, p. 185)

Owner's account men (Corn.). Workmen paid by the day. (Bainbridge)

Oxbow. A crescent-shaped lake formed in an abandoned river bend which has become separated from the main stream by a change in the course of the river.

Oxford clay. An English Mesozoic formation characteristic of the middle Oölite. (Standard)

Oxidation. A chemical union with oxygen. (Raymond)

Oxide. A compound of the element oxygen with another element or elements, as Fe_2O_3. (Roy. Com.)

Oxidize. To unite with oxygen. Many minerals and most metals oxidize with greater or less rapidity when exposed to air or water. (Weed)

Oxidized zone. That portion of an ore deposit which has been subjected to the action of surface waters carrying oxygen, carbon dioxide, etc. (Farrell). That zone in which sulphides have been altered to oxides and carbonates.

Oxidizing flame. The outer cone of the blow-pipe flame, characterized by the excess of oxygen of the air over the carbon of the gas. (Dana)

Óxido (Sp.). Oxide. (Dwight)

Oxígeno (Sp.). Oxygen. (Dwight)

Oxland-Hocking furnace. A revolving, cylindrical furnace used in Sardinia for calcining sulphide ore. (Ingalls, p. 25)

Oxonite. An explosive prepared by dissolving picric acid in nitric acid. (Webster)

Oxter (Scot.). The armpit. The apex of a reëntrant, or reëntering angle in a working face of coal.

Oxycoal gas. A mixture of oxygen and coal gas. (Standard)

Oxydaceae. The oxides and their combinations with each other; one of the four classes in T. Sterry Hunt's classification of minerals. (Standard)

Oxygen. A colorless, tasteless, odorless, chemically active, gaseous element occurring in a free state in the atmosphere of which it forms about 23 per cent by weight and about 21 per cent by volume. The most abundant of all the elements. Symbol, O; atomic weight, 16.0; specific gravity, 1.105. (Webster)

Oxyhydrogen. Consisting of a mixture of oxygen and hydrogen. (Webster)

Oxyhydrogen blowpipe. A blowpipe in which hydrogen is burned in oxygen. Streams of the two gases in the proportion to form water are forced under pressure from separate reservoirs, forming a jet, and igniting just as they issue. The heat produced is sufficient to fuse very refractory substances. Called also Compound blowpipe (Standard). The temperature of the flame is estimated at 5,000° F.

Oxyphyre. Pirsson's general name for the acidic rocks. Oxyphyre is contrasted with Lamprophyre, a corresponding name for the basic rocks. The two are complementary. *See* Lamprophyre, *also* Complementary rocks. (Kemp)

Oye! (O-o-o-o-ye!) (Mex.) An exclamation used to call attention in a hoisting shaft. (Halse)

Oysanite. A name given by Lameth to the titanium mineral anatase. (Humble)

Ozarkite (Ark.). A white, massive variety of thomsonite. (Chester)

Ozocerite; Mineral wax; Fossil wax; Native paraffin. Waxlike hydrocarbon, yellow-brown to green in color; translucent when pure; feels greasy. Streak is light to brown, and specific gravity is slightly less than 1. Soluble in carbon disulphide. (U. S. Geol. Surv.)

Ozokerine. *See* Yellow Ozokerine.

Ozone. A faintly blue gaseous substance obtained by the silent discharge of electricity in air or oxygen, and by other methods. It is an allotropic form of oxygen, is a powerful oxidizer, and comparatively unstable. It is used commercially for sterilizing water, bleaching oils, etc. (Webster). Its density is one and one-half times that of oxygen.

P.

Pábilo (Mex.). A lamp or candle wick.

Pac; Pack. A moccasin, with the sole turned up and sewed to the upper; also heavy felt half-boot worn by loggers in winter (Webster). Also used by miners in the far north.

Pachapampa (Peru). Ore about the size of a walnut picked out of waste. (Halse)

Pachucha tank. *See* Brown tank.

Pacite (Bol.). Arsenical sulphide of iron, near arsenopyrite. (Chester)

Pack. 1. A wall or pillar built of gob to support the roof; also used in the anthracite regions synonomously with the English term 'chocks' or 'nogs.' (Chance)
2. To occasion the speedy subsidence of the ore in the process of washing by beating the keeve or tub with a hammer. (Steel)
3. To fill in stopes and old mine workings with waste rock to support the roof. (Webster)
4. (Eng.) A measure of coal equal to 3 bushels. 5. A bundle of iron plates ready to be heated or rolled. (Standard)

Pack builder. One who builds packs or pack walls (Gresley). *See also* Pack, 1.

Packer. 1. A device lowered in the lining tubes, which swells automatically, or can be used to expand by manipulation from the surface at the correct time, to produce a watertight joint against the sides of the bore hole or the casing, thus entirely excluding water from higher horizons. (Mitzakis)
2. (U. S. and Aust.) A person who transports goods by pack animals; a carrier; a pack animal (Webster). Common in mining districts.
3. A man who builds or constructs a pack (Gresley). *See* Pack, 1.

Packfong (Chinese). A silver-white alloy of copper, zinc, and nickel; German silver. (Ure)

Packing. 1. A general term relating to a yielding material employed to effect a tight joint. A common example is the sheet rubber used for gaskets. The term is also applied to the braided hemp or metallic rings used in some joints, that allow considerable or incessant motion. (Nat. Tube Co.)
2. (Cornish) The final dressing of tin or copper ore in a large vat or keeve filled with water. (Davies)
3. Filling, as of mortar containing small stones. 4. The filling of a coke tower or other condenser used in the manufacture of hydrochloric acid. (Webster)

Pack road. A road or trail suitable for pack animals, but not for vehicles. (Century)

Pack saddle. A saddle made for supporting the load on a pack animal. (Webster)

Packsand. A very fine-grained sandstone so loosely consolidated by a slight calcareous cement as to be readily cut by a spade. (Standard)

Pack trail (Western U. S.). A path or narrow road for the passage of pack trains only. (Standard)

Pack train. A train of pack animals. (Standard)

Pacos (Peru). An earthy mass of reddish ore containing much iron and particles of native silver, horn silver, etc. (Ure)

Pack wall. A wall of stone or rubbish to carry the roof and keep the sides up (Gresley). *See also* Pack, 1.

Pacos (Peru). Ferruginous silver ore. (Mex.) Oxidized ores (Dwight). *P. de estaño*, small veins of cassiterite. (Halse)

Pactolian. Of, or pertaining to, the Lydian river Pactolus or its gold-bearing sands. (Standard)

Paddle. 1. A straight iron tool for stirring ore in a furnace. 2. A bat or pallet, as used in tempering clay. 3. A scoop for stirring and mixing, as used in glass-making. (Standard)

Paddle-wheel agitator. A simple stirring apparatus by which the solids are kept in suspension by paddles. It is difficult to start if the sand packs around the blades, and it is expensive both in operating and in repair costs. (Liddell)

Paddock. 1. (Aust.) An inclosure for exercising horses. The Australians being keen horsemen, took to using the word in mining. Thus when ore is in "bins", or "stored", or "stacked on the surface", is is said to be "in the paddock". (Rickard)
2. A way of working a claim, the whole mass being taken out in the form of a large square pit. (Skinner)
3. A space or platform near the mouth of a shaft or excavation for temporary storage of ore or wash

dirt. 4. An excavation for wash dirt in shallow alluvium. 5. To store ore in a paddock. (Webster)

Paddy. 1. (York.) An open lamp used by miners. (Gresley)
2. A well drill having cutters that expand on pressure. (Standard)

Paddy pan (Leic.). A skip (box) formerly used in a swinging bant for carrying miners. *See* Bant; Bont, 1, and Tackler, 2. *Also* Skep.

Page. In brickmaking, a track carrying the pallets bearing newly molded bricks. (Standard)

Pagoda stone. A Chinese limestone showing in section figures fancifully likened to pagodas, due to fossil orthoceratites. (Standard)

Pagodite. A soft variety of pinite or agalmatolite out of which the Chinese carve figures of pagodas, idols, etc. (Standard)

Paha. A low ridge or hill of glacial deposits capped by loess, determined by the configuration of the subterrane, molded by and marking the direction of the ice flows of the glacial epoch; characteristic of northeastern Iowa. (Standard)

Pahoehoe. The Hawaiian word for lava, or a flow of the same, having a smooth, ropy, fluted, or lobate surface. It is contrasted with "Aa", which refers to jagged and cindery crusts. *See* Aa. (Kemp)

Painters' naphtha. *See* Turpentine substitutes. Deodorized naphtha, of gravity 58° to 60° Bé. is sometimes employed in paints. (Bacon)

Paint gold. A very thin coating of gold on minerals. (Power)

Paint mill. A machine for grinding mineral paints.

Paint rock. *See* Ocher.

Paint thinner. *See* Turpetine substitutes.

Pair (Corn.) A party of men working together; a gang (Webster). Also spelled Pare.

Pair of gears (No. of Eng.). *See* Gears.

Pair of timbers. (So. Wales). *See* Gears.

Pairs (So. Staff.). Two shafts about 100 yards apart, sunk to the Thick coal seam. (Gresley)

Paisanite. A variety of quartz-porphyry, containing phenocrysts of microperthitic orthoclase and rarer quartz, in a groundmass of quartz and feldspar. *Compare* Comendite. (Kemp)

Paja (Sp.). 1. Straw. 2. A blasting match; *P. quemada* (Bol.), a variety of jamesonite resembling a straw. (Halse)

Pájaro minero (Venez.). The miner bird. Some of the natives have a strong belief that the miner bird is a sure indicator of alluvial gold. (Halse)

Paktong. *See* Packfong.

Pala (Sp.) Shovel; *P. de cruzo*, a round-pointed shovel; *P. cuadrada*, a square-pointed shovel. (Dwight) (Halse)

Palacra (Sp.). 1. A piece of native gold. 2. An ingot of fine gold. (Halse)

Palæophyre. Gümbel's name given in 1874 to certain porphyritic dike rocks corresponding to quartz-mica-diorites in mineralogy. They cut the Silurian strata of the Fichtelgebirge. (Kemp)

Palæophyrite. A name proposed by Stache and Von John (*compare* Ortlerite) for certain porphyrites in whose strongly prevailing groundmass are phenocrysts of plagioclase, hornblende and augite. (Kemp)

Palæopicrite. A name proposed by Gümbel in 1874, for picrites which were considered by him to be similar to the rocks from the Cretaceous formation, originally named picrite by Tschermak. Gümbel called his specimens palæopicrites because they occurred in Paleozoic strata. They are chiefly olivine and augite. More or less brown hornblende and biotite also occur. (Kemp)

Palagonite-tuff. An altered basaltic tuff containing inclusions of devitrified, basaltic glass. (Kemp)

Palanca (Sp.). 1. Lever. 2. *P. de campana*, a knocker or signaling apparatus in shafts (Halse).
3. The toggle of a rock crusher. (Dwight)

Palanque (Mex.). Barring after shots have been fired. (Dwight)

Palanthropic. In geology, according to Dawson, the earlier part of the anthropic, the post-glacial Pleistocene, during which man appeared and there was an extensive emergence of land. (Standard)

Palatinite. A name proposed by Laspeyres for certain rocks in the German Province of Pfalz, supposed by him to be gabbros with diallage and to be of Carboniferous age; but they have since been shown to be essentially diabases. The word is derived from the classic name of the district. (Kemp)

Pale brick. Brick which are underburned. (Ries)

Paleocene. The earliest of the epochs comprised in the Paleogene period, in the classification adopted by some geologists. Also the series of strata deposited during that epoch: they are regarded by some geologists as Upper Cretaceous and by others as Eocene. (La Forge)

Paleogene. The earlier of the two periods comprised in the Cenozoic era, in the classification adopted by the International Geologic Congress and used by many European geologists: it includes the Paleocene (if that be accepted), Eocene, and Oligocene epochs. Also the system of strata deposited during that epoch. Compare Neogene. (La Forge)

Paleolithic. Of, or pertaining to, the earliest known human culture, which is represented chiefly by unpolished stone implements. The paleolithic period was applied in Europe to the earliest known culture period, which was apparently sharply separated from the succeeding and much shorter period, called the Neolithic period, the two forming the Age of stone. (Webster)

Paleontology. The science that deals with the life of past geological ages. It is based on the study of the fossil remains of organisms. (Webster)

Paleoplain. In geology, an ancient plain of degradation, buried under later deposits. (La Forge)

Palevolcanic. Of effusive character and having been erupted before the Tertiary period: said of some volcanic igneous rocks and opposed to Neovolcanic. Now obsolescent. (La Forge)

Paleozoic. One of the grand divisions or eras of geologic time, preceding the Mesozoic era. Also the group of rocks formed during the Paleozoic era, which comprises, in the generally adopted classification, the Cambrian Ordovician, Silurian, Devonian, and Carboniferous systems. The beginning of the Paleozoic was formerly supposed to be marked by the appearance of life on the earth and the lowest Paleozoic strata were supposed to be the oldest fossiliferous rocks of the earth's crust, but both suppositions are now known to be incorrect. (La Forge)

Palero (Mex.). Shoveler; mine carpenter, or timberman. (Dwight)

Palisade. A line of bold cliffs, especially one showing basaltic columns. (Webster)

Pallaco (Peru). A piece of ore of good quality found on waste heaps. (Halse)

Palladium. A rare metallic element of the platinum group, found native and also alloyed with platinum and gold. Silver-white, ductile, malleable. Symbol, Pd; atomic weight, 106.7; specific gravity, 11.8. (Webster)

Palladium gold. Same as Porpezite, or gold containing palladium up to 10 per cent. (Dana)

Pallador (Peru). An ore sorter. (Halse)

Pallalla (Bol.). A sort of trowel for agitating gravel in alluvial mining. (Halse)

Pallaquear (Sp. Am.). To pick over the dumps. (Lucas)

Pallas iron. *See* Pallasite.

Pallasite. Originally proposed by Gustav Rose for a meteorite that fell near Pallas, in Russia; has been used by Wadsworth in a wider sense for both meteoric and terrestrial, ultra-basic rocks, which in the former average about 60 per cent iron and in the latter have at least more iron oxides than silica. Cumberlandite (which see) is the chief example (Kemp). Also called Pallas iron.

Pallet. 1. A board for carrying newly molded bricks. 2. A potters' wheel. 3. A paddle for mixing and shaping clay for crucibles, etc. (Standard)

Pallet boy. In brickmaking, a boy who places pallets on the dumptable. (Standard)

Palleting. A light platform in the bottom of powder magazines to preserve the powder from dampness. (Century)

Pallet molding. A method of forming bricks in sanded molds, from which they are dumped on a board called a pallet: distinguished from *slop-molding.* (Standard)

Palm. A piece of stout leather fitting the palm of the hand, and secured by a loop to the thumb; this has a flat indented plate for forcing the needle. (C. and M. M. P.). Used in sewing heavy canvas.

Palm needle. A straight triangular-sectioned needle used for sewing canvas. (C. and M. M. P.)

Palo (Mex.). Stick; piece of timber; *P. labrados*, hewn timber; *P. redondos*, round timber. (Dwight)

Pampa (Peru). An elevated plane at the base of mountains. (Halse)

Pan. 1. *See* Panning. 2. A cylindrical vat of iron, stone, or wood, or these combined, in which ore is ground with mullers and amalgamated. *See* Amalgamating pan. (Raymond)
3. A copper or galvanized iron utensil used for washing gold ore and gravel so as to separate the heavy gold by a shaking motion. It corresponds to the Cornishman's vanning shovel (Rickard). Also called Dish.
4. To wash earth, gravel, etc., in a pan in searching for gold. To yield gold in, or as in the process of panning. (Webster)
5. The solid stratum of clay, pebbles, etc., underlying soil; hardpan; used chiefly in Great Britain. (Standard). Fireclay or underclay of coal seams.
6. (Mid.). Sheet-iron vessels holding, say ¼ cwt., into which fillers rake the small coal. (Gresley)

Panabase. Same as Tetrahedrite, $Cu_6Sb_2S_7$. (Dana)

Panal de Rosa (Peru). Fissured quartz containing gold. (Halse)

Pan amalgamation. Amalgamation of silver or gold with mercury by grinding in a pan. (Duryee)

Pañar (Colom.). To collect gold-bearing sand in spoons and scoops, and deposit it in the *bateas*. (Halse)

Pancake. Same as Ribbon, 1.

Panclastite. An explosive composed of liquid nitrogen tetroxide mixed with carbon disulphide or other liquid combustible, in the proportion of three volumes of the former to two of the combustible. (Century)

Pan coal (Scot.). Small coal suitable for use at salt works, as under salt pans. (Barrowman)

Pandermite. Firm, compact, porcelain-like masses of colemanite. (Moses)

Pane. 1. (So. Staff.) A quantity of coal measuring 2 feet 6 inches high, 6 feet in width, and 6 feet under or forward. (Gresley)
2. *See* Peen.

Panel. 1. A heap of dressed ore. 2. A system of coal-extraction in which the ground is laid off in separate districts or panels, pillars of extra size being left between. (Raymond)
3. A large rectangular block or pillar of coal measuring, say, 180 by 100 yds. 4. A group of breasts or rooms separated from the other workings by large pillars. (Steel)
5. A small portion of coal left uncut. (Webster)

Panella (Braz.). A miner's term for druse. (Halse)

Panel slicing. *See* Top slicing and cover caving.

Panel working. A system of working coal seams in which the colliery is divided up into large squares or panels, isolated or surrounded by solid ribs of coal of which a separate set of breasts and pillars is worked, and the ventilation is kept distinct, that is, every panel has its own circulation, the air of one not passing into the adjoining one, but being carried direct to the main return airway. (C. and M. M. P.)

Panes (Mex.). Amalgamating pans. (Dwight)

Pan ice (Labrador). Ice formed along the shore and subsequently loosened and driven by winds and currents. (Century)

Panidiomorphic. Rosenbusch's term for those rocks, all of whose components possess their own crystal boundaries. (Kemp)

Panino (Mex.). Vein-formation; vein material; the ground or country through which the lode runs; also, the matrix. (Min. Jour.). *P. muy macizo*, the very hardest kind of vein matter or rock; *P. macizo*, rock not quite so hard, but still not requiring to be timbered; *P. favorable*, rock easily broken down by drilling, but not needing timbering; *P. blando*, generally slate or schist which can be broken easily by pick, bar, or wedge, and which must sooner or later be timbered; *P. muy blando*, usually clay shale or argillaceous schist, and requiring constantly to be held up by timbering. (Dwight)

Panizo (Peru). 1. A whitish feldspar, or kaolin; feldspathic gangue. 2. Trachyte. 3. (Chile) Country rock. (Halse)

Paneling. Division into panels or compartments; panel working. *See* Panel, 2. (Webster)

Panning (Aust. and Pac.). Washing earth or crushed rock in a pan, by agitation with water, to obtain the particles of greatest specific gravity which it contains (chiefly practiced for gold, also for quicksilver, diamonds, and other gems). (Raymond)

Pan out. To give a result, especially as compared with expectations, as in mining, the gravel *pans* out well. *See* Pan, 4.

Papa. 1. (Maori) A kind of bluish indurated pipe clay, sometimes used for whitening fireplaces. It is often as hard as stone and is then called *papa* rock. (Webster)
2. (Sp.). A nugget of gold or silver. 3. A nodule of mineral (Halse)
4. (Sp.) A potato. (Vel.)

Pantellerite. A felsophyric or vitrophyric igneous rock, virtually a sodic-quartz trachyte, containing essential anorthoclase, aegirite, and quartz, and perhaps diopside and and cossyrite. (La Forge). Applied to a group of rocks intermediate between the rhyolites and trachytes on the one hand, and the dacites on the other. They differ from all these in having anorthoclase as the principal feldspar. Cossyrite, a rare and probably titaniferous amphibole, occurs at the original locality on the island of Pantelleria, in the Mediterranean. The name was given by Förstner. (Kemp)

Pantile. A roofing tile; a gutter tile; a flat paving tile (Webster). Also spelled Pentile.

Pantograph. An instrument for copying maps, plans, etc., on any predetermined scale. (Webster)

Paper coal. A variety of brown coal deposited in thin layers like sheets of paper. (Power)

Paper spar. A variety of calcite found in thin paper-like plates. (Standard)

Par; Par value. Equality of the nominal and market values of securities or certificates of value (often called *nominal, or face par*), or the value or price at which they are issued and their market value (called *issue par*). Nominal value; face value. (Webster)

Para (Mex.). A leather apron worn by miners. (Halse)

Paracaida (Sp.). 1. A parachute. 2. A safety appliance for bringing the cage quickly to rest in case the hoisting cable breaks. (Halse)

Parachrosis. Discoloration in minerals from exposure to the weather. (Standard)

Parachute. 1. A kind of safety-catch for shaft cages. 2. In rod boring, a cage with a leather cover to prevent a too rapid fall of the rods in case of accident. (Raymond)

Paraclase. A term used by Daubrée for faults. (Power)

Parada (Sp.). A relief, or change of men, horses, or mules; a shift. (Halse). *Paradas de busca* (Mex.), miners working on a tribute; *P. a la carga*, miners working for so much per ton or *carga* of ore broken down or extracted; *P. a destajo*, miners on contract, at so much per meter, etc.; *P. a partido*, miners receiving as pay a share of the ore they mine; *P. de hacienda*, or *P. de obra*, miners working by the day. (Dwight)

Paraffin. A white, waxy, inodorous, tasteless substance, harder than tallow, softer than wax, with a specific gravity of 0.890. Its melting point is variable, depending somewhat upon its origin; it ranges between 43° and 65° C. (109° and 151° F.) An ultimate analysis yields, on the average, carbon 85 per cent. and hydrogen 15 per cent. It is insoluble in water, is indifferent to the most powerful acids, alkalies, and chlorine, and can be distilled unchanged with strong sulphuric acid. Warm alcohol, ether, oil of turpentine, olive oil, benzol, chloroform, and carbon disulphide dissolve it readily. It can be mixed in all proportions with wax, stearin, palmitin, and resin (Bacon). Paraffin is found native, as in ozocerite and hatchettite, also in peat and bituminous coal, and is contained in numerous oils, as petroleum, from which it is separated by distillation. (Standard)

Paraffin-asphalt petroleum. A combination of paraffin-base and asphalt-base petroleums. (Bacon)

Paraffin-base petroleum. Crude oil which carries solid paraffin hydrocarbons and practically no asphalt. (Bacon)

Paraffin butter. A variety of native paraffin used in making candles. (Standard)

Paraffin coal. A light-colored bituminous coal used for the production of oil and paraffin. (Mitzakis)

Paraffin fluxes. The residuals obtained from paraffin-base petroleums are characterized by containing 14½ to 4 per cent. of hard paraffin scale, consisting to a predominating degree of saturated hydrocarbons (85.6 to 74.1 per cent.) and having a specific gravity of 0.92 to 0.94. In general, it may be said that paraffin fluxes yield only a small percentage of residual coke and contain but little sulphur. (Bacon)

Paraffin oil. 1. Lubricating oil made by the dry distillation method. 2. A proprietary name for liquid petrolatum. (Bacon)

Paraffin scale. Crude paraffin wax. (Bacon)

Paraffinum. A mixture of solid hydrocarbons chiefly of the methane series; usually obtained by chilling and pressing the distillates from petroleum having high boiling point, and purifying the solid press-cake so obtained. *See* Paraffin. (Bacon)

Paraffinum liquidum. The medicinal petroleum of the British Pharmacopoeia. Sp. gr., 0.885–0.890. In the refining of Russian petroleum, the finest quality of perfumery oil is termed *paraffinum liquidum*, and for phamaceutical purpose is often subjected to a final distillation. *See* Petrolatum, liquid. (Bacon)

Paraffinum molle. According to the British Pharmacopoeia, a petroleum product corresponding to the vaseline of the United States Pharmacpoeia. (Bacon)

Paragenesis. A general term for the order of formation of associated minerals in time succession, one after another. To study the paragenesis is to trace out in a rock or vein the succession in which the minerals have developed. (Kemp)

Paragneiss. 1. In petrology, a gneiss formed by the metamorphism of a sedimentary rock. 2. A gneiss formed from a sedimentary rock by an intermediary action of an igneous magma to such an extent that a virtually new rock is formed. (La Forge)

Paragonite. A kind of mica corresponding to muscovite, but with sodium instead of potassium. (Webster)

Paragonite schist. A variety of schist in which paragonite replaces biotite. (Standard)

Parallel growth. Two or more crystals with corresponding faces parallel. (A. F. Rogers)

Parallel roads. A geological term for a series of terraces at different levels, as those of Glen Roy, Scotland. (Webster)

Paramagnetic. Opposed to diamagnetic. Applied to substances such as iron, which, when freely suspended between two magnetic poles, arranges itself in the line between them (Power). Having a magnetic permeability greater than unity. (Webster)

Paramento (Sp.). Lining of a blast furnace. (Halse)

Parameter. In minerology that rational multiple of the unit-length of any semiaxis intercepted by a crystal plane which determines its position with reference to the fundamental form. (Standard)

Paramilla (Chile). A low range of mountains. (Halse)

Paramorph. A crystal that has undergone a change in its physical properties without a corresponding change in composition (Butler). A result of paramorphism.

Paramorphism. The alteration of one mineral into another without change of composition, as augite into hornblende in uralitization. It is also used in connection with metamorphism to describe such thorough changes in a rock that its old components are destroyed and new ones are built up. (Kemp)

Paranthine. Haüy's name for scapolite. (Humble)

Parar (Sp.). To stop; *P. la bateria*, to stop the battery or mill. (Halse)

Parasitic crater. *See* Adventive crater.

Paratomous. Having planes of cleavage inclined to the axis; also, abounding with facets of cleavage. (Standard)

Parcel. 1. (So. Staff.) An old term for a ton; really 27 cwts. (Gresley)
2. (Corn.) A heap of dressed ore ready for sale. (Raymond)

Parcionero (Mex.). Partner in a mining contract. (Dwight)

Pardo (Mex.). Oxidized or surface ore. *See* Colorados. (Dwight)

Pare (Corn.). Gang or party of men. (Min. Jour.). *See* Pair.

Pared (Mex.). Vein wall. (Dwight)

Paret (Borneo). A mine. (Lock)

Pargasite. An amphibole including green and bluish-green kinds of hornblende, occurring in stout lustrous crystals, or granular. (Dana)

Parget. Gypsum, especially that from Derbyshire or from Montmartre. (Standard)

Parian. In ceramics, resembling the marble of Paros, as *Parian* biscuit. (Standard)

Parian biscuit. A hard, fine, half-vitreous, porcelain resembling Carrara marble; used for objects of art and ornament. (Standard)

Parianite. Asphalt from the Pitch lake, Trinidad. (Bacon)

Parian marble. One of the most famous of ancient statuary marbles; from the island of Paros in the Grecian archipelago. (Merrill)

Parian porcelain. A fine variety of hard porcelain used for statuettes and bas-reliefs; so called from its resemblance to Parian marble. (Standard)

Parihuela (Mex.). Handbarrow. (Dwight)

Parisite. A fluocarbonate of the cerium metals. In acute double hexagonal pyramids. Color brownish-yellow. (Dana)

Parka (Arctic). An outer garment made of the skins of birds or mammals, or of cloth, worn by the Eskimos. Also worn by prospectors and travelers in Alaska in extreme cold weather.

Parkes process. The refining of lead by the addition of zinc to molten argentiferous lead. The zinc and silver rise to the surface of the bath as a scum, which is then taken off and afterwards distilled to drive off the zinc. (Liddell)

Parliamentary pit (Scot.). A mine outlet or shaft, required by an act of Parliament. (Barrowman)

Parmazo marble. A white marble traversed by a coarse network of dark lines; from northern Italy. (Merrill)

Parol. A trade name for a fuel used in internal combustion engines. Made from paraffin by a chemical process without the use of heat. (Bacon)

Parophite. A name given by T. Sterry Hunt to a rock or mineral similar to dysyntribite. The name means 'like serpentine.' (Kemp)

Paroxysm. In geology, any violent or sudden natural occurrence, as a volcanic eruption, a sudden flood, etc. (Roy. Com.)

Parral agitator. An agitator using a number of small air lifts disposed about a circular, flat-bottomed tank in such a way as to impart a circular swirling motion to the pulp. (Liddell)

Parrilla (Sp.). Grate bar. (Dwight)

Parrot coal. 1. (Scot., No. of Eng.) A variety of cannel coal, so-called, because when on the fire it splits and cracks with a chattering noise, like a parrot talking. (Gresley)
2. Sometimes applied to gas coal when of inferior quality. (Barrowman)

Part. 1. Same as Parting, 2. 2. In founding, a section of a mold or flask, specifically distinguished (in a three-part flask) as top *part*, middle *part*, and bottom *part*. (Standard)

Part candles (Eng.). The use of candles as well as safety lamps in a mine. (Gresley)

Partido (Mex.). Division of ores between partners. Working a mine by *partido* is when the miners agree with the owners to take a certain part of the ores in place of wages. Usually the mine owner provides candles, powder, and steel, and keeps the drills sharpened, and receives, in payment of royalty and supplies, two-thirds or more of the ore taken out. This contract is renewed weekly or monthly, and the proportion of ore retained by the miners is greater or smaller according to the richness of the stopes where they work. It is generally bought from them by the mine owner himself, for various reasons. (Dwight)

Partidor (Sp.). An ore sorter. (Halse)

Patilla (Mex.). Platform left in shaft. (Dwight)

Parting. 1. A small joint in coal or rock, or a layer of rock in a coal seam. 2. The separation of two metals in an alloy, especially the separation of gold and silver by means of nitric or sulphuric acid. (Raymond)
3. A side track or turnout in a haulage road. *Entry parting*, the parting at the beginning of an entry in a slope mine. *Inside* or *swing parting*, a parting some distance from the mouth of an entry, from which the cars are hauled out by a special mule or team. *Rope parting* or *motor parting*, a parting on which trips of cars are collected for hauling out by a rope-hauling system, or electric motor. (Steel)
4. (Scot.) The manner in which a seam parts from its roof or pavement; it is a bad parting when they do not separate readily, a good parting when they do. (Barrowman)
5. The tendency of crystals to separate along certain planes that are not true cleavage planes, but which have become directions of minimum cohesion through gliding, secondary twinning, or some other external cause. 6. The line or plane of separation between the parts of a molder's flask. (Standard)

Parting flask. In assaying, a flask used in parting (Webster). *See also* Parting, 2.

Parting glass. Same as Parting flask.

Parting sand. Fine, dry sand, which is sifted over the partings in a mold to facilitate their separation when the flask is opened. (Raymond)

Parting slate. A term applied to a thin layer of slate between two seams of coal. (Thacker *v.* Shelby Coal Min. Co. 197 S. W. Rept., p. 633)

Partiversal dip. A series of local dips varying approximately 180° in compass-direction, occurring at or near the end of a plunging anticlinal axis.

Pascal's law. The principle that the pressure in a fluid not acted upon by external forces is the same at all points, or that a fluid transmits pressures equally in all directions. (Webster)

Pasilla (Mex.). Dry silver amalgam. (Dwight)

Pasillo (Sp.). In coal mining, a cross cut; break through; thurl or thurling. (Halse)

Paso (Sp.). 1. Any underground drift or gallery. 2. An ore pass or chute. 3. A mountain pass. (Halse)

Pass. 1. (Corn.) An opening in a mine through which ore is delivered from a higher to a lower level. *See* Chute. 2. In rolling mills the passage of the bar between the rolls. When the bar passes 'on the flat' it is called a flatting-pass; if 'on the edge,' an edging-pass. (Raymond)
3. A passage left in old workings for men to travel in from one level to another. (C. and M. M. P.)

Passador (Braz.). A classifier or pulp thickener. Similar to an inverted pyramid or cone. (Bensusan)

Passauite. A variety of wernerite, also called porcelain-spar. (Chester)

Pass-by; Pass-bye. 1. (Eng.) A passage round the working part of a shaft. A by-pass. (Power)
2. A siding in which cars pass one another underground; a turnout. (C. and M. M. P.)

Passing water (Scot.). When a pump bucket is worn, or otherwise not tight, it is said to be passing water. (Barrowman)

Pass-into. A transition of one mineral into another without any sudden change. (C. and M. M. P.)

Passive iron. Iron rendered non-corrodible by treatment with heat or acids. (Standard)

Pass-pipe. An iron pipe connecting the water at the back of one set of tubbing with that of another, or a pipe only in communication with one tub (Tub, 5), and open to the interior of the shaft. (Gresley)

Pasta (Mex.). 1. Amalgam of gold and silver. 2. Gold and silver bullion (Dwight).
3. (Mex.). Argentiferous ores, as blende, galena, etc. 4. (Chile) Gray copper ore; tetrahedrite. (Halse)

Paste. 1. The mineral substance in which other minerals are embedded; groundmass, as of a porphyry. (Webster)
2. A mixture of clay, variously prepared for making stoneware or porcelain. (Standard)

Pasting. The operation of mudcapping. (Du Pont)

Pat. In brickmaking, to remove the rough edge of green bricks with a stamper. (Standard)

Pataka (N. Z.). A storehouse raised above the ground. (Webster) A cache.

Patch. A small placer property. (Milford)

Patcher. 1. A driver's assitant or helper; a brakeman or trip-rider. (C. and M. M. P.)
2. One who repairs broken brattices, doors, stoppings, etc., in a mine.

Patching (So. Wales). Workings carried on at the outcrop (Gresley). Called Patchwork in Derbyshire.

Patchy. Distributed in patches or in an irregular manner as when ore occurs in bunches or sporadically. (Roy. Com.)

Pat coal (Scot.). The bottom, or lowest, coal sunk through in a shaft. (Barrowman)

Pâte (Fr.). Paste; particularly, porcelain-paste. (Standard)

Patent. 1. An instrument making a conveyance or grant of public lands. (Webster)
2. Title in fee, obtained by patent from the United States Government when there has been done an equivalent of $500 worth of work on or for each mining claim. (U. S. Min. Stat., pp. 400–426; 493–494; 563; 570–574)

Patent axe. A type of surfacing machine employed to remove irregularities from the surface of blocks of stone. (Bowles)

Patente (Chile). An annual tax on mines, amounting to $10 per hectare. (Halse)

Patented claim. A claim to which a patent has been secured from the Government, by compliance with the laws relating to such claims (C. and M. M. P.). *See also* Patent, 2.

Patent fuel (Eng.). The fuel produced by the agglomeration of coal-slack into lumps (Raymond). *See also* Briquet.

Patent survey. An accurate survey of a mining claim by a U. S. deputy surveyor as required by law in order to secure a patent (title) to the claim.

Patera process. A metallurgical process consisting of a chloridizing-roasting; leaching with water to remove base metals (some silver is dissolved and must be recovered); leaching with sodium hyposulphite for silver; precipitation of silver by sodium sulphide. The process was first carried out by von Patera at Joachimsthal (Liddell). *See also* Joachimsthal process.

Paternoster pump. A chain-pump; named from a fancied resemblance of the disks and the endless chain to a rosary. (Standard)

Pâte sur pâte (Fr.). A decoration for pottery, made of white porcelain paste, on a dark ground, so applied as to produce effects of light and shade by varying thicknesses. (Standard)

Pâte tendre (Fr.). Soft paste for porcelain. (Standard)

Patio (Sp.). 1. The yard where ores are cleaned and assorted; also, the amalgamation floor, or the Spanish process itself of amalgamating silver ores on an open floor (Raymond). *P. de amalgamación*, amalgamation court or floor; *Beneficio de p.*, the cold amalgamation process, or American heap amalgamation. It was invented by Bartolemé de Medina, Pachuca, Mex., in 1557; introduced into Peru in 1574. In 1793 mules and horses were first used in the process. 2. *Trabajar por p.* (Colom.) To quarry or make an open cut. (Halse)

Patio (Mex.). Cloth used by miners. (Dwight)

Patio process. A process for the recovery of silver by amalgamation in low heaps with the aid of salt and copper sulphate (magistral). Thorough mixing is obtained in the usual form by having horses or oxen tread the mass. (Liddell)

Patrón (Sp.). An overman. (Halse)

Patrón de oro (Sp.). Gold standard. (Lucas)

Pattern. In founding, a model, usually of wood or iron, and often in several parts to facilitate removal, about which to form a sand mold, in which a casting may be made. (Standard)

Pattern molder. One who makes sand molds for castings; a molder. (Standard)

Patterson agitator. An agitator of the Pachuca-tank type in which the air is replaced by solution or water, under pressure from a centrifugal pump. (Liddell)

Pattinson process. A process in which lead, containing silver, is passed through a series of melting kettles, in each of which crystals of a poorer alloy are deposited, while the fluid bath, ladled from one kettle to the next, is proportionately richer in silver. In mechanical pattinsonation the operation is performed in a cylindrical vessel, in which the bath is stirred mechanically, and from which, as the richer alloy crystallizes, the poorer liquid is repeatedly drained out. Steam pattinsonation is a variety of the Pattinson process, in which steam is conducted through the lead bath to assist the refining. (Raymond)

Pattinson's pots. A series of pots for separating silver and lead by making use of the fact that the melting-point of the lead-silver alloys is higher in proportion as the percentage of silver is greater. (Standard)

Paulistas (Braz.). Natives of São Paulo who first discovered gold near that city. (Halse)

Pavement. The floor of a mine. (Raymond)

Paving brick. Vitrified brick used for paving purposes. (Ries)

Paving stone. Stone prepared, or suitable, for paving; stone used in pavements (Standard). Usually in large flat slabs, or square blocks, as Belgian block.

Paving tile. Tile used for floors. (Standard)

Pavonado. 1. (Peru) Tetrahedrite, frequently argentiferous. 2. *Pavonados* (Peru), a rich zone composed principally of sulphides and sulphantimonates of silver. (Halse)

Pavonazetta marble. *See* Pavonazza.

Pavonazza; Pavonazetta marble. A siliceous limestone of various shades of green, blue or gray, alternating with bands of white. Formerly much used in southern Italy. So called from its resemblance to the plumage of a peacock; also called Phrygian marble. (Merrill)

Pawn (Derb.). A security put up by a miner when he makes claim to a vein discovered by or in the possession of another. The claim is settled by trial at a Barmote court. (Mander)

Paxillose. In geology, resembling a little stake.

Pay. 1. Profitable ore. *See* Pay dirt. 2. (Eng.) The day upon which, or the place where, wages are made up or paid. (Gresley)

Pay bill; Pay sheet (Scot.). A statement showing details of workmen's wages for a stated period, usually a fortnight. (Barrowman)

Pay dirt; Pay rock. 1. (West. U .S.) Earth, rock, etc., which yields a profit to the miner. (Webster) 2. (So. Afr.) Auriferous gravel rich enough to pay for washing or working. (Skinner)

Pay gravel. In placer mining, a rich strip or lead of auriferous gravel. (Hanks)

Payne's process. A process for preserving timber and rendering it incombustible by impregnating it successively with solutions of sulphate of iron and calcium chloride in vacuo. Paynize. (Webster)

Pay ore. Those parts of an ore body which are both rich enough and large enough to work with profit (Power). *See* Pay dirt; Pay gravel; Pay rock.

Pay out. To slacken or to let out rope. (C. and M. M. P.)

Pay shoot. A portion of a deposit composed of pay ore. (Farrell)

Pay streak. That portion of a vein which carries the profitable or pay ore.

Peach (Corn.). Chlorite. (Raymond)

Peachblow. 1. A light-purple glaze inclining to pink, seen on some Oriental porcelain. 2. A kind of ware thus glazed or tinted. (Standard)

Peach stone (Corn.). A greenish-colored soft stone; chloritic schist. (Davies)

Peachy lode (Corn.). A lode filled with a greenish chlorite, of peachy luster and loose cellular texture. (Power)

Peacock coal (Eng.). Iridescent coal. (Webster)

Peacock copper. A synonym for Bornite. (A. F. Rogers)

Peacock ore. An iridescent variety of copper ore; bornite; also chalcopyrite when slightly oxidized on the surface.

Pea coal. In anthracite only,—coal small enough to pass through a mesh three quarters to half an inch square, but too large to pass through

a three-eighth inch mesh. When Buckwheat coal is made, the size marketed as Pea is sometimes larger than the above; known also as No. 6 coal. (Chance)

Pea grit (Eng.). A grit composed of rounded or oval concretionary masses like peas; often like crushed peas. (Oldham)

Peak. A headland or promontory; the top or one of the tops of a hill, mountain or range, ending in a point. (Webster)

Pea ore (Eng.). Rounded grains of hydrated peroxide of iron, or silicate of iron, commonly found in cavities of Jurassic limestone (Power). The mineral limonite, occurring in round grains about the size of a pea (Webster). Also called Bean ore.

Pearce turret furnace. A furnace consisting of a narrower hearth, bent around a circle, the circumference of which is a little greater than the length of the hearth, so that the two ends do not quite meet. Used for calcining sulphide ores. (Peters, p. 205; Hofman, p. 175; Ingalls, p. 101)

Pearlash. Commercial potassium carbonate. (Century)

Pearl diabase. *See* Variolite.

Pearlite. 1. *See* Perlite, 1. Also called Pearlstone. 2. A eutectoid of cementite and crystallized iron formed by slow cooling of molten steel. Synonyms, Pearlyte, Perlite, Cryocarbide, and Pearly constituent. (Tieman)

Pearl mica. Same as Margarite, 2.

Pearl opal. Same as cacholong; an opaque, bluish white, porcelain white, pale yellowish or reddish variety of opal. (Dana)

Pearl sinter. A variety of opal. (Dana)

Pearl spar. Dolomite occurring in rhombohedrons having a pearly luster. (Power)

Pearlstone. Same as Perlite, 1.

Pearly. Applied to minerals having a luster like a pearl, as talc, brucite, stilbite, etc. (Dana)

Pearlyte. A mixture of ferrite and cementite having a pearly appearance when lamellar (Standard). *See also* Pearlite, 2.

Peas (Eng.). *See* Pea coal.

Pease's electric tester. An instrument in which the vapor of petroleum is ignited by an electric spark passing above the oil cup, which rests in a water bath. (Mitzakis)

Peastone. Same as Pisolite.

Peasy. 1. Applied to small pieces of ore, the weight of which may be estimated by the hand. (Morine) 2. (No. of Eng.) Lead ore in grains about the size of peas. (Standard)

Peat. A dark-brown or black residuum produced by the partial decomposition and disintegration of mosses, sedges, trees, and other plants that grow in marshes and like wet places. It may be identified as the dark-colored soil found in bogs and swamps, commonly called muck, although technically the term "muck" should be restricted to such decayed vegetal matter as is impure and contains too much ash to burn readily. True peat consists principally of carbon, hydrogen, and oxygen, in varying proportions, and because of its high carbon content, it will ignite and burn freely when dry. (Mineral Resources of the United States, 1917, Pt. 2, p. 261.)

Peat bed. An accumulation of peat.

Peat bog. A bog containing peat; an accumulation of peat. (Webster)

Peat charcoal. Charcoal made from peat. (Standard)

Peat coal. 1. A natural product intermediate between peat and lignite. 2. An artificial fuel made by carbonizing peat. (Webster)

Peat coke. Same as Peat charcoal. (Standard)

Peat cutter. A paring-plow for cutting peat. (Standard)

Peatery. A peat bog or bank (Webster). Also Petary.

Peat gas. Gas made by distilling peat. (Webster)

Peat hag. A pit or quag formed by digging out peat. (Standard)

Peat machine. A machine for grinding and briqueting peat. (Webster)

Peat man. A digger or seller of peat. (Webster)

Peat moor. Same as peat moss. In the United States such deposits are called swamps or bogs. (Century)

Peat moss. 1. Any moss from which peat has been formed. 2. (Eng.) A peat bog; also, peat itself. (Webster)

Peat press. A press machine for making peat into blocks of artificial fuel. (Standard)

Peat reek. The smoke of peat. (Webster)

Peat soil. A rich dark soil containing peat, especially the soil of a reclaimed peat bog. (Standard)

Peat spade. A spade with an L-shaped blade for cutting out peat in blocks. (Webster)

Peat tar. A tar obtained from the distillation of peat. The distillates obtained contain from 2 to 6 per cent of tar. (Bacon)

Peaty. Resembling or containing peat; having the nature of peat. (Standard)

Peau d'orange. In ceramics, a decoration or finish of a surface such that it resembles in roughness the skin of an orange. (Standard)

Peavy. A stout lever like a cant hook, but having the end armed with a strong and sharp spike. (Webster)

Pebble. 1. A small roundish stone, especially one worn round by the action of water; a pebblestone; also a gem occurring in the form of pebbles. 2. Transparent, colorless quartz; rock crystal; as Brazilian pebble. (Webster)

Pebble crystal. A crystal, as of quartz in the rough state, worn into the form of a pebble. (Standard)

Pebble jack. Zinc blende in small crystals or pebble-like forms not attached to rock, but found in clay openings in the rock. (C. and M. M. P.)

Pebble powder. Gunpowder pressed into large cubical grains, to render it slow burning. It is inferior to the perforated prismatic powder in that the burning surface constantly decreases, and therefore the rate of emission of gas is greater at the beginning than at the end. (Webster)

Pebblestone. A pebble; also pebbles collectively. (Webster)

Pebbleware. A variety of Wedgwood ware with a variegated body of different colored clays intermingled, called according to pattern, agate, Egyptian pebble, granite, lapis-lazuli, porphyry, serpentine, verd-antique, etc. (Standard)

Pechera (Mex.). Leather or cloth, worn by a laborer carrying ore, to protect neck and back. (Dwight)

Pecho (Sp.). 1. The front wall of a shaft furnace. 2. *Barreno de p.*, a horizontal drill hole. (Halse)

Pecking up (So. Staff.). Elevating or propping up with rough stones, bricks, rubbish, etc. (Gresley)

Pecos ore. 1. A gossan containing lead and silver. 2. (Tasmania) A yellowish, earthy mixture of oxides of iron, lead, and antimony containing silver; mostly massicot. (Power)

Pectinate, or Pectinated mineral. A mineral that presents the appearance of close and nearly parallel filaments. (Standard)

Pectolite. An acid silicate of sodium and calcium, $H_2O.Na_2O.4CaO.6SiO_2$. (Dana)

Pedernal. 1. (Mex.) A massive compact variety of quartz; flint; hornstones. 2. *Pedernales* (Peru), silver ores formed of siliceous sand impregnated with oxide of iron. (Halse)

Pedial class. In crystallography, the class without any symmetry. (A. F. Rogers)

Pedimento (Chile). A written petition for a piece of mining ground (Halse). A synonym of Petición, Solicitud.

Pedis possessio. The actual possession of a piece of mineral land to the extent needed to give the locator room to work and to prevent probable breaches of the peace, but not necessarily to the extent of a mining claim. (Hanson *v.* Craig, 170 Fed. Rept., p. 65; Zollers *v.* Evans, 5 Fed. Rept., p. 172; Costigan on Mining Law, p. 156)

Pednan. 1. (Corn.) The upper part of a buddle. 2. A deposit of ore detached from a lode. (Davies)

Ped'n cairn (Corn.). A bunch of ore at a distance from the lode. (Min. Jour.)

Pedra (Port.). 1. A stone; *P. de ferro*, ironstone; *P. de lages*, flagstone. (Halse)

Pedregal (Southwestern U. S.). A stony tract; lava field. (Standard)

Pedreiro (Braz.). A stone mason. (Bensusan)

Pee. 1. Two veins crossing each other obliquely. (Skinner)
2. (Derb.) A piece of lead ore. (Davies) A variation of pea.

Peeler. An iron implement with flattened end and ring handle, used by a baller in placing blooms, ingots, etc., in a reheating furnace. (Standard)

Peevy. Same as Peavy.

Peg. 1. To mark out a miner's claim by pegs at the four corners, each bearing the claimant's name. (Webster). Sometimes used as peg out. 2. A surveyor's mark. 3. (Forest of Dean). *See* Notchsticks.

Pegado (Colom.). A local and small deposit of pay dirt. (Halse)

Pegador (Sp.). Foreman in charge of blasting. (Dwight)

Peganite. A hydrous phosphate of aluminium occurring in crystalline crusts of a green color. (Century)

Pegar (Sp.). To fire the loaded drill holes. (Dwight)

Pegging (Aust.). Act of marking by pegs. (Webster)

Peggy (York.). Synonymous with Pick. (Gresley)

Pegmatite; Giant granite. An igneous rock, generally coarse grained but usually irregular in texture and composition, composed mainly of silicate minerals of large size, including quartz, feldspar, muscovite, biotite, tourmaline, beryl, lithia minerals, zircon, etc. Some pegmatites carry minerals containing rare earth metals, tin, tungsten, tantalum, urannium, and others. (U. S. Geol. Surv.)

Pegmatitic; Pegmatoid. Characteristic of, pertaining to, formed of, containing, or occurring in pegmatite. (La Forge)

Pegmatization. Metamorphic alteration to pegmatite. (Standard)

Peirce-Smith Process. A basic-converting process for copper matte in a magnesite-lined converter. The iron of the matte is fluxed by silica added before the process begins. (Liddell.)

Pelagic; Pelagian. Formed in deep water far from land; said of some marine deposits and contrasted with Terrigenous. (La Forge)
2. Opposed to Littoral which belongs to the sea shore, and Estuarine to that formed in an estuary. (Power)

Pelagite. A name given to certain manganese nodules obtained in deep-sea soundings. (Chester)

Pelatan-Clerici process. A continuous process of dissolving silver or gold in cyanide solution and simultaneously precipitating the precious metals with mercury in the same vessel, an electrical current assisting precipitation. (Liddell)

Pelatan furnace. A furnace for the calcination of fine pyritic or other sulphide ores. (Peters, p. 173)

Peldon (So. Staff.). Hard and compact siliceous rock found in coal mines. (Gresley)

Pelionite. A name proposed by W. F. Petterd for a bituminous coal (Pelion coal) resembling English cannel coal, from near Monte Pelion, Tasmania. (Bacon)

Pele's hair. A fibrous, basaltic glass from the Hawaiian Islands, named after a local goddess. (Kemp)

Pelite. In general, any sedimentary rock, indurated or not, formed of clay. Especially, a thick-bedded argillaceous sedimentary rock lacking a shaly fracture; a mudrock. (La Forge)

Pelitic. Pertaining to, characteristic of, or formed of pelite; composed of fine argillaceous sediment or clay. (La Forge)

Bella. 1. (Sp.) A mass of metal in its crude state. 2. (Mex.) Amalgam left after the mercury has been squeezed out. (Halse)

Pella; Plata Pella (Mex.). Silver amalgam. (C. and M. M. P.).

Pelo (Peru). Stibnite in very small needles. (Halse)

Pelt (Scot.). Carbonaceous stone associated with a coal seam. *See also* Bone (Barrowman). Waste; rubbish.

Pen. 1. (Scot.). In longwall working, a narrow airway, more particularly an airway formed along the solid coal. (Barrowman)
2. A device to dam or pen the water in a stream; a dam. (Webster)

Peña (Sp.). 1. A large stone or rock in its natural state. Rock; cliff; a term used in southwestern United States. 2. A large sledge hammer. 3. (Colom.). Bed rock or bottom; *P. hervida, picadora ó caladora*, fissured and porous bed rock; *P. mara*, carmine-colored and spotted bed rock; *P. falsa*, false bed rock. 4. (Colom.) County rock. (Halse)

Penarth beds (Eng.). The beds between the Trias and Lias; so called from their occurrence at Penarth, in Somersetshire. (Oldham)

Pencatite. *See* Predazzite.

Pencil. (N. Y. and Pa.). A bluestone quarryman's term for interbedded shale in bluestone deposits. (Bowles)

Pencil mark (Ballarat, Aust.). A thin bed of dark slate about the thickness of the lead of a carpenters pencil, which is parallel with the indicator (Power). *See* Indicator, 4.

Pencil stone. A compact variety of pyrophyllite used for making slate pencils. (Webster)

Pendiente (Sp.). 1. Slope or declivity. 2. Gradient; grade. 3. Dip. 4. Hanging wall or roof. (Halse)

Pendulum buffer (Vt.). Large wooden blocks covered with felt pads that are propelled back and forth by means of a crank and pitman (Bowles). Used for polishing monumental stone.

Peneplain. A surface of slight relief and very gentle slopes, formed by the subaerial degradation of the land almost to baselevel; the penultimate state of the old age of the land produced by such degradation. 2. By extension, such a surface uplifted to form a plateau and subjected to renewed degradation and dissection. (La Forge)

Peneplanation. The subaerial degradation of a region approximately to base level, forming a peneplain. (La Forge)

Penetrating pulley. A pulley around which a wire cable runs in cutting marble. Its thickness is less than the diameter of the wire and, consequently, it can follow the wire as the latter cuts into the stone. (Bowles)

Penetration. 1. In laboratory investigations of paraffin, waxes, etc., the distance, expressed in tenths of a millimeter, penetrated by a No. 2 cambric needle operated in a machine for the purpose and under known conditions of loading, time, and temperature. The degree of solidity of bituminous materials. 2. In construction, the entrance of bituminous material into the interstices of the metal of the roadway. (Bacon)

Penetration method. The method of constructing a bituminous macadam pavement by pouring or grouting the bituminous material into the upper course of the road metal before the binding of the latter has been completed. (Bacon)

Penetration twin. A twin crystal in which the two parts interpenetrate each other: contrasted with Contact twin. (La Forge)

Penistone series (Eng.). The lower division of the coal measures, consisting of sandstone and shales with coal and ironstone. (Century)

Penitent (Fr.). A fireman who, in early coal mining days, was employed to explode (purposely, in order to get rid of it) the fire damp. So called on account of the resemblance of his dress to that of certain religious orders. (Gresley)

Pennine system (Eng.). The original and typical series of carboniferous rocks, comprising the Upper old red sandstone, the Mountain limestone, the Millstone grit, and the coal-measures. The correlated strata in the United States are the Catskill red sandstone and carboniferous series, exclusive of the Permian. (Standard)

Penning. *See* Cribbing, 2.

Penninite. A green crystallized chlorite from the Penninie Alps. Composition essentially the same as clinochlore, $H_8(Mg.Fe)_5Al_2Si_3O_{18}$. (Dana)

Pennsylvanian. The second of the three epochs comprised in the Carboniferous period, in the classification generally used by American geologists. Also the series of strata, formerly called the Coal Measures, deposited during that epoch. It is equivalent to the Dimetian epoch and series of the classification used by many European geologists. (La Forge)

Pennystone. 1. A band of clay ironstone. (Gresley)
2. (Eng.) *See* Penistone series.

Pennyweight. A unit of weight equal to 24 grains, 0.05 troy ounce, 0.0549 avoirdupois ounce, and 1.5552 grams. A pennyweight of fine gold has a value of $1.0335 or 4.25 shillings.

Pensky-Marten tester. An instrument somewhat similar to the Abel apparatus, largely employed for determining the flashing point of lubricating oils by the close test. (Mitzakis)

Penstock. 1. A sluice or gate for restraining, deviating or otherwise regulating the flow of water, sewage, etc.; a floodgate. 2. A closed conduit, tube, or pipe for conducting water, as to a water wheel. 3. The barrel of a wooden pump. (Webster)

Pentagonal dodecahedron. In the isimetric system, a form, of pyritohedral symmetry, enclosed by twelve faces, each parallel to one axis and cutting the other two axes at unequal distances; a pyritohedron. (La Forge)

Pentavalent. Having a valence or combining power of five. (Webster)

Pentelic marble. One of the most famous of ancient statuary marbles; from Mt. Pentellicus, near Athens, Greece. (Merrill)

Penthouse; Penthus. A wooden hut or covering for the protection of men when shaft sinking (Gresley). Also called Pentice.

Pentice. *See* Penthouse.

Pentlandite. A sulphide of iron and nickel, (Fe,Ni)S; 42 per cent iron; 22 per cent nickel. (Dana)

Pentrough. The trough in which the penstock of a water wheel is placed. (Century)

Peón. 1. (Mex.) Helper; a common laborer. *P. suelto*, roustabout. 2. The movable vertical post of an *arrastre*. 3. A prop, post, or stall. (Halse)

Pepe (short of Joseph) (Sp.). A boy who holds the light for the *barretero*, and assists him in other ways at certain hours. (Rockwell)

Pepena (Mex.). 1. Rich ore; smelting ore. 2. Picked ore. 3. The act of picking, sorting, or cobbing. (Halse)

Pepenado (Mex.). Dressed ore. (Dwight)

Pepenador (Mex.). Ore sorter. (Dwight)

Pepenadores (Sp.). Ore cleaners. (Davies)

Pepenar (Mex.). To sort ore. (Dwight)

Peperino. A kind of volcanic rock, formed by the cementing together of volcanic sand, cinders, scoriæ, etc. (Comstock)

Peperita (Sp.). Volcanic sand. (Halse)

Pepita (Sp.). A nugget, usually of gold, but may be of silver or platinum. (Halse)

Pequenes (Chile). Heaps or piles formerly used for roasting copper ores, with firewood as fuel. (Halse)

Perch. 1. A measure of masonry containing 24¾ cu. ft., 16½ by 1½ by 1. It is usually taken as 25 cubic feet. The term is falling into disuse and varies locally. (Merrill)
2. A measure of length equal to 5½ yards; a rod; or pole; *also* a square rod. (Webster)

Perched blocks (*blocs perchés*). *See* Perched rock.

Perched rock. A large mass of rock which, after glacial transportation, has been lodged in some conspicuous isolated position. Called also Perched block. (Standard)

Percolate. To pass through fine interstices; to filter; as water percolates through porous stones. (Webster)

Percussion cap. *See* Detonator; Primer.

Percussion figure. A figure consisting of radiating lines formed in such minerals as mica and chlorite by a blow with the point of a somewhat sharp instrument (Dana). Called also Strike figure.

Percussion powder. Powder so composed as to ignite by a slight percussion; fulminating powder. (Webster)

Percussion sieve. An apparatus in which ore is sorted according to size. It consists essentially of superimposed, oppositely inclined sieves, both mechanically agitated by vertical lever and having water sluices. (Webster)

Percussion system of drilling. *See* Drilling; Freefall, and Churn drill, 1.

Percussion table. An inclined table, agitated by a series of shocks, and operating at the same time like a buddle. It may be made self-discharging and continuous by substituting for the table an endles rubber cloth, slowly moving against the current of water, as in the Frue vanner. (Raymond)

Percussive. Of, or pertaining to, percussion; operative or operated by striking, as a percussive drill. (Webster)

Pérdida (Mex.). Loss in *patio* amalgamation. Loss in general. *See also* Consumida. (Dwight)

Perfil (Sp.). Profile; side elevation. (Halse)

Perforadora (Sp.). A machine drill. (Dwight)

Perforar (Sp.). To bore a deep bore hole; *P. un túnel*, to tunnel. (Halse)

Perfumery oil. A refined Russian petroleum. The finest quality is used in pharmacy as *paraffinum liquidum*. (Bacon)

Periclase. Magnesia, MgO. In cubes or octahedrons, and in grains. Cleavage cubic. (Dana)

Periclinal. Dipping in all directions from an elevated center (Power). *See also* Quaquaversal.

Pericline. A variety of albite. (Dana)

Pericline twin. A twin crystal, in the monoclinic system, whose twinning axis is the orthoaxis of the crystal. (La Forge)

Peridot. The gem variety of olivine. (A. F. Rogers)

Peridotite. A granular igneous rock composed essentially of olivine, generally with some form of pyroxene, and with or without hornblende, biotite, chromite, garnet, etc, (La Forge)

Perimorph. A mineral of one species inclosing one of another species. *See also* Endomorph. (Webster)

Period. The unit of geologic time of the second rank; a division of an era. The coordinate stratigraphic unit is System. (La Forge) The geological application of the word varies with different authors. In the scheme of nomenclature proposed by the International Geological Congress *period* is the chronological term of the second order, to which *system* is the corresponding stratigraphic term; as Silurian *period* or system. In the scheme of the United States Geological Survey *period* has the same rank, but its corresponding stratigraphic term is *system*. (Standard)

Periodic law. One of the fundamental chemical laws that the properties of an element are periodic functions of the atomic weight (Liddell). It is also called Mendeleeff's law.

Periodic system. A classification of the elements according to Mendeleeff's law. (Webster)

Peripheral moraine. A minor terminal moraine, marking only a temporary halt of the glacier during recession. Also called Moraine of recession. (Standard)

Peristerite. A whitish adularia-like albite, slightly iridescent. (Standard)

Perito (Mex.). An expert in any science or art (Dwight). An appraiser; a skillful workman. (Halse)

Perjong (Malay). A crowbar. (Local)

Perkins. An imperfectly burned brick; a place brick. (Standard)

Perkins joint. A joint consisting of threaded pipe and coupling, both threaded straight (no taper). The one end of the pipe is left square and the other is beveled to a knife edge at midthickness. Used in Baku oil field. (Nat. Tube Co.)

Perknite. A name from the Greek word for dark, and proposed by H. W. Turner as a collective term for the rocks usually called pyroxenites and hornblendites. Mineralogically the perknites consist chiefly of monoclinic pyroxene and amphibole with subordinate orthorhombic pyroxene, olivine, and feldspar. Chemically they are lower in alumina and alkalies than the diorites and gabbros, and lower in magnesia than the peridotites. (Kemp)

Perla (Mex.). An assay bead. (Dwight)

Perlite. 1. Volcanic glass with concentric, shelly texture and usually with a notable percentage of water. (Kemp)
2. *See* Pearlite, 2.

Perlitic. Resembling perlite; concentrically lamellar: applied to a microscopic structure in glassy rocks resembling that of an onion. (Standard)

Permanent monument. A monument of a lasting character for marking a mining claim. It may be a mountain, hill, ridge, hogback, butte, canyon, gulch, river, stream, waterfall, cascade, lake, inlet, bay, arm of the sea, stake, post, monument of stone or bowlders, shafts, drifts, tunnels, open cuts, or well known adjoining patented claims. (Meydenbauer *v.* Stevens, 78 Fed. Rept., p. 792.) (Also U. S. Min. Stat., pp. 227-231.)

Permian. The last of the three epochs comprised in the Carboniferous period, in the classification generally used. Also the series of strata deposited during that epoch. By some geologists the Permian is ranked as a period and system. (La Forge)

Permissible. That may be permitted; allowable; admissible. (Webster)

Permissible explosive. An explosive similar in all respects to samples that passed certain tests by the Federal Bureau of Mines, and used in accordance with the following conditions: 1. That the explosive is in all respects similar to the sample submitted by the manufacturer for test. 2. That detonators—preferably electric detonators—are used of not less efficiency than those prescribed, namely, those consisting by weight of 90 parts of mercury fulminate and 10 parts of potassium chlorate (or their equivalents). 3. That the explosive, if frozen, shall be thoroughly thawed in a safe and suitable manner before use. 4. That the quantity used for a shot does not exceed 1½ pounds (680 grams), and that it is properly tamped with clay or other noncombustible stemming.

After an explosive has passed the required tests and its brand name has been published in a list of permissible explosives, it is not a permissible explosive if one or more of any of the following conditions prevail: 1. If kept in a moist place until it undergoes a change in character. 2. If used in a frozen or partly frozen condition. 3. If used in excess of 1½ pounds (680 grams) per shot. 4. If the diameter of the cartridge is less than that designated in the column "smallest permissible diameter." 5. If fired with a detonator or electric detonator of less efficiency than that prescribed. 6. If fired without stemming. 7. If fired with combustible stemming. (Tech. Paper 169, U. S. Bur. Mines.) For use in gaseous and dusty coal mines.

Permissible motors. A motor the same in all respects as a sample motor that has passed certain tests made by the Federal Bureau of Mines and installed and used in accordance with the conditions prescribed by the bureau. *See* Explosion-proof motor.

Permitted explosives (Eng. and Aust.). Certain explosives allowed to be used in fiery mines (mentioned periodically in "Statutory Rules and Orders," issued by the Home Office, London), which are supposed to be safe (Power). The term Permissible is used in the United States.

Pernetti. 1. (It.) In ceramics, iron or hard pottery pins or tripods to support an article in a kiln; stilts; spurs. 2. The marks left on a baked article of pottery by the supporting pins; pernetti marks. (Standard)

Pernot furnace; Post-Pernot furnace. A reverberatory puddling or smelting furnace, having a circular, inclined revolving hearth (Raymond). Used in making steel.

Perovskite; Perofskite. Calcium titanate. $CaTiO_3$. Isometric. Luster adamantine to metallic-adamantine. Color pale-yellow, honey-yellow, orange-yellow, reddish-brown, grayish-black. Transparent to opaque. (Dana)

Perol (Colom.). A small iron pan in which a pestle works for grinding and amalgamating gold-bearing pyrite. (Halse)

Perpend. 1. A header extending through a wall so that one end appears on each side of it; a perpend-stone; border; bondstone; through-stone or through-binder. Called also, Parping; Perpender; Perpent. 2. A vertical joint, as in a brick wall. (Standard)

Perpendicular throw. The distance between the two parts of a disrupted bed, dike, vein, or of any recognizable surface, measured perpendicularly to the bedding plane or to the surface in question. It is measured, therefore, in a vertical plane at right angles to the strike of the disrupted surface. (Lindgren, p. 123)

Perpeno (Sp. Am.). Cleaning up. (Lucas)

Perpetuity. An annuity whose payments are supposed to continue forever. (E. B. Skinner, p. 77)

Pershbecker furnace. A continuously-working shaft-furnace for roasting quicksilver ores, having two fire places at opposite sides. The fuel is wood. (Raymond)

Persian red. *See* Indian red.

Persilicic. Containing more than 60 per cent of silica: said of some igneous rocks; same as and much to be perferred to Acid and Acidic, which it is replacing. (La Forge)

Pertenencia (Mex.). Mining claim. Under the modern Mexican mining law, a square of land 100 meters on a side (*i. e.*, 1 hectare=2.471 acres) is the minimum unit. This unit is called a *pertenencia* (Dwight). In Peru, equals 2 hectares, or 200 m. long by 100 m. wide; in Argentine, 300 m. by 200 m. to 300 m., according to dip; in Colombia, 600 m. by 240 m., a lode mining claim equaling three of these. (Halse)

Perthite. A variety of feldspar consisting of closely interlaminated orthoclase or microcline and albite. (La Forge) A name given by Thomson to parallel intergrowths of orthoclase and albite, originally described from Perth, Ontaria. (Kemp)

Pervious bed. A bed or stratum that contains voids through which water will move under ordinary hydrostatic pressure. (Meinzer)

Pesador (Mex.). A weighmaster. (Dwight)

Peso (Sp.). 1. A Spanish or Mexican dollar.
2. A monetary unit and silver coin of the Philippines worth $0.50. 3. A variable silver coin of several Central and South American countries. 4. Weight, gravity; *P. bruto*, gross weight; *P. neto*, net weight. 5. Balance; scales; *P. de muelle*, spring balance. (Halse)

Pestle. 1. An implement for pounding and breaking or braying substances in a mortar. 2. Any of various instruments for pounding or stamping, as a stamp in a stamp mill. 3. To pound, pulverize, bray, or mix, as with a pestle. (Webster)

Petalite. A lithium-aluminum silicate, $LiAl(Si_2O_5)_2$, or, $Li_2O.Al_2O_3.8SiO_2$, usually massive, foliated and cleavable. (Dana)

Petaloid. Having the form, texture, or appearance of a petal (Webster). Applied to the structure seen in minerals that split up into pieces with a smooth polished concave-convex surface which fit into one another somewhat like the petals of an unopened flower bud. (Power)

Petanque; Petlanque (Mex.). Ruby silver. Tetrahedrite, and other rich silver minerals. (Dwight)

Petary. *See* **Peatery.**

Peter; Peter out. To fail gradually in size, quantity, or quality (Raymond). *e. g.* The mine has *petered* out.

Petit granite marble. A bluish marble studded with innumerable fine white points caused by fossil crinoids and polyps; from Ecausines, Belgium. (Merrill)

Petlanque (Sp.). The same as pyrargyrite. In Chili it is called *Rosicler oscuro.* (Century). Also silver ores which are conspcuous in the matrix for example, *petlanque colorado* is the red antimonial silver whether crystallized or otherwise. (Min. Jour.)

Petra dura (Italy). Hard and fine stones in general, as those used for inlay and the like, in distinction from the softer stones used in building. (Webster)

Petralite. An explosive composed of saltpeter, wood or charcoal, and antimony. (Webster)

Petralogy. *See* Petrology.

Petre. Niter, saltpeter. (Webster)

Petrean. Of, or pertaining to, rock, rocky. (Webster)

Petrescence. The process of changing into stone; petrifaction. (Standard)

Petrical. Fletcher's name for the coarser structural features of rocks. *See* Lithical. (Kemp)

Petrifaction. The process of petrifying, or changing into stone; conversion of organic matter, including shells, bones, etc., into stone or a substance of stony hardness. (Webster)

Petrified wood. *See* Wood, 2.

Petrify. To become stone. Organic substances, such as shells, bones, wood, etc., embedded in sediments, become converted into stone by the gradual replacement of their tissues, particle by particle, with corresponding amounts of infiltrated mineral matter. Thus not only the outward forms but even the minutest details of the organic tissues are preserved. (Roy. Com.)

Petro. 1. A stone or rock. 2. A proprietary name for liquid petrolatum.

Petrosene. A greenish-yellow hydrocarbon with a pearly luster and needle-like crystals, obtained by the distillation of petroleum residue at a red heat. (Bacon)

Petrogeny. That branch of petrology which treats of rocks as parts of the earth's crust, and of their origin, mode of formation, and geologic relations, and which is studied mainly by means of field investigations. (La Forge) *Compare* Petrology and Petrography.

Petrographer. One who is versed in or engaged in petrography, or the study of rocks. (Century)

Petrographic microscope. The same as Polarizing microscope.

Petrographic province. A region or district in which some or all of the igneous rocks are regarded as consanguineous, or as derived from a common parent magma; a comagmatic district. (La Forge)

Petrography. That branch of petrology which treats of rocks as mineral aggregrates, aside from their geologic relations, and is studied mainly by laboratory methods, largely chemical and microscopical. Also, loosely, petrology or lithology. (La Forge) The description and systematic classification of rocks. (Webster)

Petrol. A variant for petroleum or its derivatives, particularly gasoline or motor spirit. (C. and M. M. P.)

Petrolatum. A neutral, tasteless, odorless substance derived from the distillation of petroleum. Three forms are recognized: *liquid*, a colorless, or yellow oil; *soft*, a white or yellowish semisolid substance; *hard*, a white or yellowish waxlike mass (Webster). Called also in the trade, by different makers, Cosmoline, Saxoline, Vaseline, Petroline, etc. (Standard)

Petrolatum liquidum. The medicinal high-boiling petroleum oil of the United States Pharmacopoeia. *See* Petrolatum. (Bacon)

Petrolatum oil. A colorless, straight-reduced, viscous, neutral oil, possessing a gravity of 32¾° to 34° Bé., a flash-point of 415° F., a fire test of 480° F., a cold test of 20° F., and a viscosity of 185 to 200. It is also termed 'medicinal oil.' (Bacon)

Petrolene. A liquid hydrocarbon mixture obtained from bitumen or asphalt. (Century)

Petróleo (Sp.). Petroleum. (Dwight)

Petroleum. An oily, inflammable, liquid mixture of numerous hydrocarbons, chiefly of the paraffin series, found in the earth. The petroleums found in different areas vary widely in composition and appearance (U. S. Geol. Surv.). The best known of the bitumens, and, next to coal, the most important of all carbon compounds. It occurs naturally, oozing from crevices in rocks, floating on the surface of water, or in subterranean deposits in rocks, from which it may be obtained by boring. (Bacon). Also known as Rock oil, Mineral oil, Natural oil, Coal oil, Earth oil, Seneca oil.

Petroleum is a mineral, and the same may be said of salts and phosphates, and of clay containing alumina and other substances in the earth. (Union Oil Co., In re 23 Land Decisions, p. 229)

Lands chiefly valuable for the deposits of petroleum contained therein are mineral lands within the meaning of the mining laws, and subject to location and entry as such. (Union Oil Co., In re, 25 Land Decisions, p. 357; Tulare Oil and Min. Co., *v.* So. Pac. R. R. Co., 29 Land Decisions, p. 271; Chrisman *v.* Miller, 197 U. S. p. 320)

Deposits of petroleum oil come within the definition of mineral character of land, and is sufficient to exclude such land from a railroad grant if discovered before patent issues. (So. Pac. R. R. Co., In re, Land Decisions, p. 265)

Oil or petroleum lands are mineral lands within the meaning of that term in this grant. (Burke *v.* So. Pac. R. R. Co., 234, U. S. p. 669)

Petroleum asphalt. The residues of asphalt-base petroleum, known commercially as petroleum asphalt. (Bacon)

Petroleum benzine. The petroleum benzine of the German Pharmacopoeia consists of the colorless, nonfluorescent portions of petroleum, possessing a specific gravity of 0.640 to 0.670, and distilling almost entirely between 55° and 75° C. *See* Benzine, Light petroleum, and Canadol. (Bacon)

Petroleum briquet. A briquet made of petroleum, soft soap, resin, and soda-lye wash. The mixture is heated, allowed to solidify, run into molds, and then heated in a furnace for about 15 minutes. (Bacon)

Petroleum car. A railroad car carrying a tank or tanks, designed for the transportation of petroleum in bulk (Century). A tank car.

Petroleum coke. The residue obtained by the distillation of petroleum. It usually shows the following composition: Volatile and combustible matter, 5 to 10 per cent; fixed carbon, 90 to 95 per cent; ash, from a trace to 0.3 per cent; sulphur, from 0.5 per cent to 1 per cent. On account of its purity it has found application in metallurgical processes and in making battery carbons and carbon pencils (electric carbons). (Bacon)

Petroleum ether. A volatile inflammable liquid used as a solvent for caoutchouc, oils, etc. (Webster). Some refiners have applied this designation to the products ranging in specific gravity from 0.590 to 0.666 (108° to 80° Bé.) that is, cymogene, rhigolene, and gasoline. *See* Benzine, Canadol, Light petroleu, Keroselene, and Sherwood oil. Russian petroleum ether varies in specific gravity from 0.650 to 0.660 at 15° C. (Bacon). Also frequently applied to naphtha.

Petroleum furnace. A furnace for burning petroleum, as under a steam boiler. (Century)

Petroleum naphtha. A term which is loosely employed; it often denotes the first fraction (b. p., up to 150° C.) obtained on distillation of crude oil, but is also applied to any low-boiling petroleum product, as Naphtha, Benzine, etc.

Petroleum ointment. A variety of petrolatum.

Petroleum pitch. *See* Pitch, 6.

Petroleum spirit. A volatile liquid obtained by the distillation of petroleum (Webster). A term variously used, but is sometimes applied to a petroleum distillate of a density of 0.71 to 0.74 and a boiling point of 90° to 140° C. It is used as a solvent. (Bacon)

Petroleum still. A still for separating the hydrocarbon products from crude petroleum. (Standard)

Petroleum tailings. *See* Residuum, 1.

Petroliferous. Containing or yielding petroleum. (Standard)

Petroline. A solid substance, analogous to paraffin, obtained in the distillation of Rangoon petroleum. Also, a term applied to a Scottish oil having a flash point of 126° F. (Bacon)

Petrolize. To treat or impregnate with petroleum, or a petroleum product. (Webster)

Petrology. The science of rocks, treating of their origin, construction, etc., from all aspects and in all relations; lithology. It includes petrogeny and petrography. (La Forge)

Petrosilex. An old name for extremely fine, crystalline porphyries and quartz-porphyries and for those finely crystalline aggregates we now know to be devitrified glasses; also for the ground masses of the former, which though not glassy are yet not resolvable by the microscope into definite minerals. *See also* Felsite, Microfelsite. It was practically a confession by the older petrographers that they did not know of what the rock consisted. (Kemp) Also called Hornstone.

Petrous. Hard, like stone; as, *petrous* phosphates; *petrous* marl. (Standard)

Petuntze (China). A variety of feldspar that is mixed with kaolin, and used by the Chinese in the manufacture of porcelain. (Standard)

Petzite. Telluride of silver and gold, $(Ag,Au)_2Te$. The gold content ranges from 18.2 to 25.6 per cent and the silver from 40.7 to 46.8 per cent. (U. S. Geol. Surv.)

Pewter. 1. An alloy of tin and lead. Other metals are often added, or the lead is replaced entirely with copper, zinc, antimony, etc. (Raymond)
2. A marble-worker's polishing material, made by calcining tin. (Standard)

Pewterer's solder. Hard pale solder, or middling pale solder. (Standard)

Pewter mill. A lapidary's wheel used for stones of the hardness of amethyst, agate, etc. (Webster)

Peya de cobre (Mex.). Copper amalgam. (Dwight)

Pez (Sp.). 1. Pitch; tar; *P. mineral*, asphalt. 2. *Peces*, more or less isolated lenses of coal. (Halse)

Phacolite. A colorless variety of chabazite in twins of lenticular shape. (Webster)

Phacolith. A lenticular mass of igneous rock intruded between adjacent strata in the apex of a fold. (La Forge) Literally, 'lens-rock.'

Phanerite. Any phanerocrystalline igneous rock. (Webster)

Phanerocrystalline. Having all crystals large enough to be seen with the unaided eye; that is, megascopically crystalline (Iddings, Igneous Rocks, p. 191). Opposed to cryptocrystalline.

Phantom crystal. A crystal in which an earlier stage of crystallization is marked in some way. (A. F. Rogers)

Pharmacites. A word used by M. E. Wadsworth to include all minerals employed in medicine. (Power)

Pharmacolite. A hydrous arsenate of calcium. Probably $HCaAsO_4+2H_2O$. (Dana)

Pharmacosiderite. A hydrous arsenate of iron, perhaps $6FeAsO_4 2Fe(OH)_3+12H_2O$, commonly occurring in green or yellowish-green cubic crystals. (Webster)

Phase. 1. A variety differing in some minor respect from the dominant or normal type; a facies: ordinarily used in the detailed description of igneous rock masses. (La Forge) 2. In physical chemistry, a homogeneous, physically distinct portion of matter in a non-homogeneous system, as the three *phases*—ice, water, and aqueous vapor. 3. In physics, the point or stage in the period to which the rotation, oscillation, or variation has advanced, considered in its relation to a standard position or assumed instant of starting. This relation is commonly expressed in angular measure. (Webster)

Phase angle. The angle expressing phase, or phase difference. (Webster)

Phase converter. A machine for converting an alternating current into an alternating current of a different number of phases and the same frequency. (Webster)

Phase displacement. A change of phase whereby an alternating current attains its maximum earlier or later. An inductance would cause a lag, a capacity would cause an advance, in phase. (Webster)

Phase meter. A device for measuring the difference in phase of two alternating currents or electromotive forces. (Webster)

Phase rule. A generalization with regard to two systems of chemical equilibrium, discovered by Prof. J. W. Gibbs. It may be stated thus: The degree of variableness (number of degrees of freedom) of a system is equal to the number of components minus the number of phases, plus two. Thus, if the components be salt and water, and the phases, salt, ice, saturated solution, and vapor, the system is invariant; that is, there is only one set of conditions under which these four phases can exist in equilibrium. If only three phases be considered, the system is univariant; that is, fixing one condition, as temperature determines the others. (Webster)

Phassachate. A lead-colored agate. (Standard)

Phátáng (No. Himalaya). A quantity of gold-dust melted into a lump, having a value of about 8 rupees (16s.), and used as currency. (Lock)

Phenacite. A beryllium ortho-silicate, Be_2SiO_4. Sometimes used as a gem. (Dana)

Phengite. 1. A kind of transparent or translucent stone, used by the ancients for windows. It was probably selenite or crystallized gypsum. 2. A variety of muscovite. (Webster)

Phenix-stone. An artificial stone in which furnace-slag is used in place of sand. (Century)

Phenocryst. A porphyritic crystal; one of the relatively large and ordinarily conspicuous crystals of the earliest generation in a porphyritic igneous rock. (La Forge) A name suggested by J. P. Iddings, for porphyritic crystals in rocks. It has proved an extremely convenient one, although its etymology has been criticized. It may be best to change to phanerocryst, just as in botany, phenogam has yielded to phanerogam; but one form or the other is a necessity. (Kemp)

Phenocrystalline. Same as phanerocrystalline.

Phenocrystic. Containing, characterized by, or pertaining to phenocrysts. (Standard)

Phenol. A colorless or pinkish crystalline substance, C_6H_5OH, produced by the destructive distillation of many organic bodies, as wood, coal, etc., and obtained from the heavy oil from coal tar. Commonly known as carbolic acid. (Webster)

Philadelphite. A pearly, brownish-red, micaceous vermiculite that occurs in contorted and wrinkled plates. (Standard)

Philippium. A supposed metallic element discovered in the mineral samarskite. It proved to be a mixture of yttrium and terbium. (Webster)

Phillipite. A compact, blue, hydrated copper and iron sulphate, $Fe_2Cu(SO_4)_4.12H_2O$, produced by decomposition of chalcopyrite. (Standard)

Philosopher's stone. An imaginary stone, or solid substance or preparation, believed to have the power of transmuting the baser metals into gold or silver, and hence much sought for by the alchemists (Webster)

Philosopher's wool. *See* Zinc oxide.

Phlegraean fields. The country around Naples, so named by the Greeks, from the traces of igneous action everywhere visible. Also called Campi Phlegraei or the Burnt fields. (Comstock)

Phlogiston. A flame; a blaze. The hypothetical principle of fire or inflammability formerly regarded as a material substance. (Webster)

Phlogiston theory. The theory that every combustible substance is a compound of phlogiston and the phenomena of combustion are due to phlogiston leaving the other constituent behind. It has been replaced by a modern theory which assigns to oxygen the leading rôle in chemical changes. (Webster)

Phlogopite. A magnesium mica, near biotite in composition, but containing little iron. (Dana)

Pholerite. A clay-like mineral closely related to or identical with kaolinite. (Century)

Pholidolite. A grayish-yellow, hydrous silicate of potassium, magnesium, iron and aluminum in minute crystalline scales. (Webster)

Phonolite. An aphanitic or aphanophyric igneous rock consisting of essential orthoclase or anorthoclase and nephelite, and accessory amphibole, pyroxene, or mica. (La Forge) Leucite may replace the nephelite and yield leucite-phonolites. The name is Klaproth's rendering into Greek of the old name Clinkstone. (Kemp)

Phosgene. A heavy gas made by combining carbon monoxide and chlorine. $COCl_2$, used for bleaching glass; also used in warfare.

Phosgenite. A chlorocarbonate of lead, $Pb_2Cl_2CO_3$, occurring in tetragonal crystals of a white, yellow, or grayish color and adamantine luster (Webster). Called also Corneous lead, Horn lead.

Phosphate of lime. *See* Apatite.

Phosphate rock. A sedimentary rock containing calcium phosphate. The form in which the phosphate occurs is obscure (U. S. Geol. Surv.). The three main classes which have been exploited in the United States are *land rock*, occurring in clayey, gravelly, or compacted beds below the surface of the earth; *river rock*, a darker variety obtained from river and stream beds, and the *oölitic* phosphates of Tennessee. (Webster)

Phosphates. Salts formed by combining phosphoric acid with an alkali. Sodium, potassium, ammonium and calcium phosphates are used in fertilizers. None of these are used to a large extent except the calcium phosphate. *See* Phosphate rock.

Phosphatic slag. Same as Basic slag. (Standard)

Phosphine. A hydride of phosphorus, PH_3, analogous to ammonia. (Webster)

Phosphor bronze. A kind of bronze of great hardness, elasticity, and toughness, whose superiority is due to the introduction of a small amount of phosphorus, usually as a compound of copper (phosphor copper) or with tin (phosphor tin). (Webster)

Phosphor copper. An alloy made by fusing granulated copper with bone ash and charcoal; used in making phosphor bronze. (Standard)

Phosphorescence. The continued emission of light by a substance (not incandescent) produced especially after heating, exposure to light, or to an electrical discharge. (Dana)

Phosphoric acid. Any of three oxyacids of phosphorus known respectively as ordinary or orthophosphoric acid, H_3PO_4; pyrophosphoric acid, $H_4P_2O_7$, and metaphosphoric acid, HPO_3. (Webster)

Phosphorite. Massive calcic phosphate, of the composition of apatite, but usually lacking crystal form. (Kemp)

Phosphorize. To combine or impregnate with phosphorus. (Century)

Phosphor tin. An alloy made by heating phosphorus (6 parts) with tin-sponge (94 parts); used in making phosphor bronze. (Standard)

Phosphorolite. Wadsworth's name for phosphatic rocks, guano-phosphorite, apatite, etc. (Kemp)

Phosphorus. A nonmetallic element of the nitrogen group, usually obtained as a white or yellowish, translucent, waxy substance with a disagreeable smell and a faint glow in moist air. Symbol, P.; atomic weight, 31.04; specific gravity, 1.83. (Webster)

Phosphorus disease. A disease of workers in phosphorous, marked especially by necrosis of the jaw bone (Webster). Called also Phosphor-necrosis.

Phosphorus steel. Steel in which phosphorus is the principal hardening element. Good steel may contain 0.3 per cent phosphorus, but the carbon must be very low. (Webster)

Photoceramics. The art or practice of photographing on china or pottery. (Standard)

Photogene. A trade name for a shale-oil distillate, of specific gravity from 0.72–0.81 and boiling point from 145°–150° C. It is used as an illuminating oil. (Bacon)

Photomicrograph. An enlarged or macroscopic photograph of a microscopic object, taken by attaching a camera to a microscope. (Webster)

Photoxylon. Guncotton in which the cellulose of wood pulp is used instead of cotton. (Standard)

Phreatic. Of or pertaining to a well; applied to underground waters reachable, or probably reachable, by drilling wells. (Webster)

Phreatic explosion. An explosion occurring in the roof of an igneous body, due to the expansion of volatile matter, and not extruding incandescent matter. (Daly, p. 282)

Phrygian marble. *See* Pavonazette.

Phthanite. Hauy's name for siliceous schists. Its use has recently been revived in America by G. F. Becker, who applies it to certain silicified shales in California (Kemp). Chert.

Phthisis. A wasting or consumption of the tissue. Formerly applied to many wasting diseases, but now usually restricted to pulmonary phthisis, or consumption (Webster). *See* Anthracosis.

Phrygian stone. A light pumice-like stone, anciently used in dyeing. (Standard)

Phyllite. A foliated metamorphic rock of sedimentary origin and argillaceous composition, intermediate between slate and mica schist. It is more micaceous than slate and more finely crystalline than mica schist and its fracture is intermediate between the smooth even cleavage of slate and the rather splintery fissility of schist. (La Forge)

Phyllite slate. 1. Clay slate (called also *muscovite phyllade*), or, restrictedly, clay slate rendered subcrystalline by minute superinduced scales of mica (called *phyllite* alone). 2. Clay slate containing lamellæ of the mineral phyllite, and related to ottrelite. (Standard)

Phyre. A suffix used in naming rocks that are porphyritic, as vitrophyre, orthophyre, granophyre, etc. (Kemp)

Physalite. A coarse, nearly opaque variety of topaz. Same as Pyrophysalite. (Dana)

Physic. To treat (molten iron) with an oxidizing compound capable of combining with the sulphur and phosphorus. (Standard)

Physical mineralogy. That branch of mineralogy which treats of the physical properties of minerals. (La Forge)

Physics. 1. That branch of science which treats of the laws and properties of matter, and the forces acting upon it; especially that department of natural science which treats of the causes that modify the general properties of bodies, *e. g.*, gravitation, heat, light, magnetism, electricity, etc. (Power)
2. Also, a treatise on natural philosophy or physics. (Webster)

Physiography. Physical geography; a description of the natural features of the surface of the earth. (Power)

Phytocollite. A black gelatinous hydrocarbon, related to dopplerite; found below a peat bed at Scranton, Pa. (Bacon)

Piauzite; Piauzit. An asphaltoid substance, melting at 315° C.; it has a brownish or greenish-black color and a specific gravity of 1.220. After fusing, it burns with an aromatic odor and leaves about 6 per cent of ash. It is soluble in potassium hydroxide and in ether. (Bacon)

Picacho (Mex.). Summit of a mountain peak. (Halse)

Picador. 1. (Mex.). One who taps a furnace (Dwight).
2. In coal mining, an undercutter. (Halse)

Picar. 1. (Mex.). To tap a furnace for slag or bullion. (Dwight)
2. To hew or undercut. 3. *P. un hilo* (Colom.), to discover or strike a lode; *P. un agua*, to determine the level of a ditch. (Halse)

Pick. 1. A heavy iron or steel tool, pointed at one or both ends, and often curved, wielded by means of a wooden handle inserted in an eye between the ends; used in various forms by quarrymen, roadmakers, miners, and stone dressers; a pickax. (Webster)
2. To dress the sides of a shaft or other excavation. 3. To remove shale, dirt, etc., from coal. (Gresley)
4. To select good ore out of a heap. (Davies)

Pick-dressing. In stone cutting, a tooling of the face of a stone with a sharp pick or hammer. (Standard)

Picker. 1. A small tool used to pull up the wick of a miner's lamp. 2. A person who picks the slate from the coal in an anthracite breaker. 3. A mechanical arrangement for removing slate from coal. (Steel)
4. A hand chisel for dzhuing, held in one hand and struck with a hammer. (Raymond) *See also* Dzhu.
5. (Eng.) A sharp-pointed cutting tool used as an accessory to a mizer. (Gresley)
6. A sharp-pointed steel rod used in lifting wooden patterns from the sand after they have been rammed therein. 7. A tool for piercing a mold; a piercer. 8. A miner's needle, used for picking out the tamping of a charge that has failed to explode. 9. In brickmaking a spike-toothed shaft for breaking up clay to be fed to the hopper. (Standard)

Pickeringite. Magnesia alum, $MgSO_4Al_2(SO_4)_3+22H_2O$. In long fibrous masses; and in efflorescences. (Standard)

Picket. An iron rod, pointed at one end, and usually painted alternately red and white at one foot intervals, used by surveyors as a line of sight (B. F. Tibby.) *See* Range pole.

Pick hammer. A hammer with a point, used in cobbing. (Raymond)

Picking. 1. (Scot.) The falling of particles from a mine roof about to collapse. (Barrowman)
2. Picking the eyes out of a mine is to extract over a prolonged period an undue proportion of the richest ore, thus lowering the average grade of the remaining ore reserves. (Skinner)
3. Rough sorting of ore. 4. A soft or not fully burned brick. (Webster)

Picking belt. A traveling belt made of sheet iron placed horizontally or at an angle, used for conveying coal or ore to a bin or wagon, while boys pick out rock or other waste material (Power). Rubber-covered canvas belts are also used for the same purpose.

Picking chute. A chute along which boys are stationed to pick the slate from the coal. (Chance)

Picking rod. A 1¼-inch steel rod about 20 feet long used to ram into the tap hole, while casting, to dislodge obstructions preventing a good run. (Willcox)

Picking table. A flat, or slightly inclined, platform on which the coal or ore is run to be picked free from slate or gangue.

Pickle. 1. In metal working, a bath of dilute sulphuric or nitric acid, etc., to remove burnt sand, scale, rust, etc., from the surface of castings, or other metallic articles.
2. To treat with, or steep in, pickle. (Webster)

Pickling. Cleaning sheet-iron or wire by immersion in acid. (Raymond)

Pick machine. A machine used to undermine or shear coal by heavy blows of short steel points attached to a piston driven forward and back by compressed air. Commonly called a Puncher. (Steel) *Compare* Chain-breast machine.

Pickman (Scot.). A man who digs coal with a pick; a hewer; a miner. (Barrowman)

Pick tongs. Tongs for handling hot metal. (Webster)

Pick-up (Mid.). To reduce the stock of coal. (Gresley)

Pick-ups (Alaska). Nugget gold picked up during mining operations prior to sluicing.

Pickwork. Cutting coal with a pick, as in driving headings. (Gresley)

Pico (Sp.). 1. A pickaxe. 2. A miner's pick. 3. A miner's striking hammer. 4. A small hammer used in ore sorting. 5. A peak of a mountain. (Halse)

Picota (Sp.). The top or peak of a mountain. (Halse)

Picotah. A kind of sweep used in India for raising water from well. *See also* Shadoof. (Webster)

Picotite. A variety of spinel containing chromium and iron. (Dana)

Picric acid. A yellow crystalline compound, $C_6H_3N_3O_7$, obtained variously, as by the action of nitric acid on phenol. It is used in dyeing and is an ingredient in certain explosives. Called also Carbazotic acid, Chrysolepic acid, Trinitrophenic acid (Standard). Sterilized gauze treated with a weak solution of the acid is used generally around mines in the first-aid treatment of burns, scalds, etc.

Picrite. A variety of peridotite composed essentially of olivine and augite. (La Forge)

Picrolite. A columnar or fibrous variety of serpentine. (Standard)

Picromerite. A hydrous sulphate of magnesium and potassium from the salt mines of Stassfurt. (Century)

Picture. A screen to keep off falling water from men at work. (C. and M. M. P.)

Picul (Malay). A commercial weight varying in different countries and for different commodities. In China, Japan, and Sumatra it is 133⅓ pounds. In the Philippines it is usually 140 pounds (Webster). Also spelled Pickul.

Pie (Sp.). 1. Foot or base of a mountain. 2. *P. de amigo*, buttress or strut; *P. de gallo*, a diagonal brace; *P. derecho*, a vertical brace; a post. 3. (Sp.) A foot; a measure of length, or 27.85 cm. or 11 inches. 4. (Peru) Exposing a new face so as to increase the effect of a blast. It is done by firing the lower holes first and the upper ones afterwards. (Halse)

Piece (Scot.). Food taken by a workman to his work (Barrowman). A lunch. *See also* Bait.

Piece time (Scot.). Meal time. (Barrowman)

Piece wage. A wage paid to the worker at so much per piece, or unit of product. (Webster)

Piece work. Work done by the piece or job; work paid for at a rate based on the amount done, rather than on the time employed. (Webster)

Piedmont. Lying or formed at the base of mountains; as a piedmont glacier. A piedmont alluvial plain is formed at the foot of a mountain range by the merging of several alluvial fans. (Webster)

Piedmont glacier. A type of glacier formed at the base of one or more glaciers by the expansion of the ice over a lateral valley or a broad plain; an ice lake. Called also Malaspina glacier. The Malaspina Piedmont glacier in Alaska, the only one fully described, has an area of 1,500 square miles. (Standard)

Piedmontite. A variety of epidote containing manganese. (Dana)

Piedra (Sp.). A stone, rock, or mineral; *P. arenosa*, freestone; *P. de azufre*, sulphur rock; *P. berro queña*, granite; *P. bruta* (Mex.), country rock; barren rock; *P. caliza*, limestone, *P. córnea* (Mex.), chert, flint; *P. de campana*, phonolite; *P. de candela*, flint stone; *P. de mano* (Mex.), a hand specimen; *P. de molino*, a millstone; *P. de mollejon*, sandstone; *P. dura*, any hard flint-like stone; *P. imán* (Sp.), load-stone; *P. inga*, pyrite; *P. mármol*, marble; *P. mineral*, ore; *P. negra* (Venez.), greenish-gray felstone; *P. pez*, pitch stone; *P. podrida*, rotten stone; *P. pomez*, pumice stone; *P. preciosa*, a gem or precious stone. (Halse)

Piel. An iron wedge for piercing stone. (Standard)

Piercer. 1. A blasting needle. (Ure) 2. In founding, a wire for venting a mold (Standard). *See* Picker, 7.

Piercing shot (Scot.). A shot in the roof, or brushing, designed to bring down an increasing thickness of stone. (Barrowman)

Pierelle (Fr.). A clay-covered irregular mass of stone, filling a ditch. (Standard)

Pierre-Perdu (Fr.) Blocks of stone, or concrete, heaped loosely in the water to make a foundation, as for a sea wall. (Webster)

Pier stone (Scot.). A hard variety of freestone. (Gresley)

Pietra (It.). Stone: used in phrases, as *pietra dura*. (Standard)

Pietra dura (It.). Inlaid work of hard stones set in marble. (Standard)

Pietra serena (It.). A gray sandstone quarried near Fiesole, Italy, and used for building in Florence and other Italian cities. (Standard)

Piezocrystallization. In petrography, crystallization under pressure caused by orogenic forces. (Webster)

Piezoelectricity. Electricity produced or developed by pressure, as in quartz. (Standard)

Pig. 1. An oblong mass of metal that has been run, while molten, into a mold excavated in sand; specifically, iron from the blast furnace run into molds excavated in sand (Century). An ingot or cast bar of metal. 2. Any of the molds or channels in the pig bed. 3. Collectively, pig iron, pig lead, etc. (Webster) 4. A 301-pound mass of lead. (Standard)

Pig back. To add pig iron to a molten charge too much decarburized in the acid open-hearth process. (Webster)

Pig bed. The sand bed in which are made the excavations into which iron is run in casting pigs (Standard). *See also* Pig. 2.

Pig boiling. Wet puddling. (Standard)

Pigeonhole. 1. A room driven directly into the coal seam from the edge of a strip pit. 2. Any small poorly equipped coal mine. (Steel)

Pig foot. 1. An iron clamp shaped like a pig's foot used to attach the jack to the feed chain of a continuous electric coal cutter. 2. A pipe jack with a pig foot at one end. (Steel)

Pig hole. A hole in a steel furnace, through which to put, in a crucible, an extra charge of pig iron. (Standard)

Pig iron. Crude cast-iron from the blast furnace. When the furnace is tapped the molten iron flows down a runner molded in sand, from which it enters the sows or lateral runners, flowing from these again into the pig beds, the separate parallel molds of which form the pigs. In each bed the ingots lie against the sow like suckling pigs, whence the two names. *Mine pig* is pig iron made from ores only; *cinder pig* from ores with admixture of some forge or mill cinder. (Raymond)

Pig lead. Commercial lead in large oblong masses, or pigs. (Standard)

Pigment. Any coloring material. Specifically, any dry earthy substance that, mixed with a liquid vehicle forms paint: of mineral origin, as ocher; vegetal, as dogwood; or animal, as cochineal. (Standard)

Pig metal. Metal in pigs, as iron from a smelting furnace. (Standard)

Pig sticker. A man delegated to the duty of punching or knocking pig iron out of chills or molds at a blast furnace pig-casting machine. (Willcox).

Pigsty (Aust.). A timber crib or chock used in timbering wide seams or lodes. (Halse)

Pigsty timbering. Hollow pillars built up of logs laid crosswise for supporting heavy weights. (C. and M. M. P.)

Pigtailer (Joplin, Mo.). One employed by the mining company to assist trammers in long-distance haulage, where tramming is done by men. An assistant trammer.

Pig tin. Tin cast, or for casting into pigs. (Webster)

Pike. 1. A pick or pickax. 2. The horn or back of an anvil. 3. A peaked mountain or hill top, or a mountain or hill with such a top; a peak. 4. A turnpike road. 5. A sharp-pointed staff. (Webster)

Pikeman (So. Staff.) One who uses a pick or pickax, as a miner; a pickman. (Webster)

Pike pole. A pole 12 to 20 feet long with a long spike in one end, used in directing floating logs (Webster). Also frequently used in raising structural timbers, as in raising the frame of a building.

Piking. *See* Cobbing, 1.

Pila (Mex.). 1. A stone basin used for storing amalgam from the *patio* process. *P. apuradora*, a tank to receive the residues from the washing troughs. 2. A large evaporating pan

used in salt works. 3. (Colom.) A pit or reservoir dug out or made by damming a creek and used in gravel washing. 4. *P. de mineral*, a pile of ore. (Halse)

Pilador (Colom.). A wooden instrument moved by the stamps to indicate that ore is short in the battery; a tell-tale. (Halse)

Pilandite. A porphyritic phase of hatherlite. (Kemp)

Pilar (Mex.). A pillar of rock or ore. (Dwight)

Pilar el molino (Colom.). Said of noise produced by stamps when ore is short in the mortar box. (Halse)

Pilarite. An aluminous variety of chrysocolla. (Standard)

Pilch. 1. (Corn.) A portion of the lode let to miners to work on tribute. (Davies)
2. A thick apron worn by peat diggers. (Standard)

Pile. 1. The fagot or bundle of flat pieces of iron prepared to be heated to welding-heat and then rolled. 2. To make up into piles or fagots. 3. Long thick laths, etc., answering in shafts, in loose or "quick" ground, the same purpose as spills in levels, piles being driven vertically. (Raymond)
4. A large stake or pointed timber driven in the earth, as to support foundations of buildings in wet or yielding ground or, where the ground is soft, to support a building, pier, or other superstructure or to form a cofferdam; also an iron post or pillar, or a cylinder of concrete, used in place of the pile. (Webster)
5. A fortune. A miner who has made money has made his pile.

Pile cap. In hydraulic engineering, a beam connecting the heads of piles. (Century)

Pile dam. A dam made by driving piles and filling the interstices with stones. The surfaces are usually protected with planking. (Century)

Pile driver. A machine for driving piles, usually a high frame with appliances for raising to a height a heavy mass of iron (the monkey), which falls on the pile. (Webster)

Pile hoop. An iron band put around the head of a timber pile to prevent splitting. (Century)

Pile shoe. An iron point fitted on a pile. (Century)

Pileta (Mex.). 1. Sump of a mine. 2. Basin, pot, or crucible of a smelting furnace. (Dwight)

Piling. *See* Pile, 3 and 4.

Pillar. 1. A solid block of coal, etc., varying in area from a few square yards to several acres. (Gresley)
2. A piece of ground or mass of ore left to support the roof or hanging wall in a mine. (Hanks)

Pillar-and-breast. A system of coal mining in which the working places are rectangular rooms usually five or ten times as long as they are broad, opened on the upper side of the gangway. The breasts usually from five to twelve yards wide, vary with the character of the roof. The rooms or breasts are separated by pillars of solid coal (broken by small cross headings driven for ventilation) from five to ten or twelve yards wide. The pillar is really a solid *wall* of coal separating the working places. When the object is to obtain all the coal that can be recovered as quickly as possible, the pillars are left thin; but where this plan is likely to induce a crush or squeeze that may seriously injure the mine, larger pillars are left and after the mine has been worked out, the pillars are 'robbed' by mining from them until the roof comes down and prevents further working. In the steeply inclined seams of the anthracite regions the pillar-and-breast system is employed by working the bed in 'lifts' (Chance). Also called Pillar-and-stall, Post-and-stall, Bord-and-pillar.

Pillar-and-room. *See* Room-and-Pillar.

Pillar-and-stall. A system of working coal and other minerals where the first stage of excavation is accomplished with the roof sustained by coal or ore (Gresley). *See* Pillar-and-Breast; Post-and-Stall.

Pillar-and-stope. *See* Square-set stoping.

Pillar coal. Coal secured in pillar-robbing.

Pillar-drive. A wide irregular drift or entry, in firm dry ground, in which the roof is supported by pillars of the natural earth, or by artificial pillars of stone, no timber being used. (Duryee)

Pillaring (Aust.). The process of extracting pillars (Power). Also called Robbing pillars; Pulling pillars.

Pillaring back (No. Staff.). Robbing pillars. *See* Drifting back. (Gresley)

Pillar man. A man who builds stone packs in mine workings. (Gresley)

Pillar roads. Working roads or inclines in pillars having a range of longwall faces on either side. (Gresley)

Pillar-robbing. 1. The systematic removal of the coal pillars between rooms or chambers so as to regulate the subsidence of the roof. Also called pillar drawing. 2. The removal of ore pillars in sublevel stoping, or slicing.

Pillar-robbing and hand-filling. *See* Sublevel stoping.

Pillar-working. Working coal in much the same manner as with the Pillar-and-Stall system. (Gresley)

Pillion (Corn.). Tin that remains in the slag after the first melting (Webster). It is recovered by repeated stamping, screening and washing.

Pilolite. A name given to certain minerals previously called Mountain cork and Mountain leather. (Chester)

Pilón (Sp.). 1. A stone trough. 2. A stamp or stamper. 3. Pestle of a mortar. 4. A large wooden mortar for grinding maize. (Halse)

Piloncillos (Mex.). A collection of cone-shaped rocks. (Lucas)

Pilotaxitic. Having holocrystalline structure in which the groundmass consists essentially of microliths of feldspar; said of certain rocks, as the porphyrites. (Standard)

Pilot burner. A small burner kept lighted to rekindle the principal burner when desired, as in a flash boiler (Webster). The light so maintained is called a Pilot-light or Pilot-flame.

Pilot method. The method of excavating a tunnel by driving a small tunnel ahead, and then enlarging its dimensions. (Webster)

Pilot tunnel. A small tunnel driven ahead of a main tunnel to determine its grade and direction. (Standard)

Pilot valve. A small hand-operated valve to admit liquid to operate a valve difficult to turn by hand. (Webster)

Pilquen (Peru). The tribute system. (Halse)

Pilz furnace. A circular or octagonal shaft furnace, maintaining or increasing its diameter toward the top, and having several tuyères; used in smelting lead ores. (Raymond)

Pimelite. A massive or earthy apple-green, hydrous silicate, containing magnesium, nickel, aluminum, and iron; named from its unctious quality. (Standard)

Pimple metal. A furnace product containing about 78 per cent of copper, formed in the smelting of copper ores. (Standard)

Pimple-stone. Pebblestone. (Webster)

Pimpley (Shrop.). Bind containing ironstone nodules. (Gresley)

Pin. 1. (Scot.) A tally for counting tubs or cars of ore or coal. Pins were formerly made by the miners, each miner's pins having a distinguishing device, initial, or number. (Barrowman). *See* Wedge rock.
2. (Eng.). A thin bed of ironstone in the coal measures. (Gresley)

Piña (Mex.). 1. Silver amalgam pressed in the form of a cone to be retorted under a capellina. *See* Pella. 2. The spongy or porous cone of silver left after evaporation of the mercury in the patio process of amalgamation. (Standard)
3. Cone for sample grinder. (Dwight)
4. (Chile) Bullion. (Halse)

Pinacoid. In all systems of crystallography, but the isometric, an open form of two parallel faces parallel to two of the axes. (La Forge) If the planes are parallel to both lateral axes, it is called a basal pinacoid; if to the longer lateral and the vertical axis, a *macropinacoid;* if to the shorter lateral and vertical axes, a *brachypinacoid;* if to the inclined axes and the vertical axis, a *clinopinacoid;* if to the ortho axis and the vertical axis, an *orthopinacoid.* (Webster)

Pinch. 1. A compression of the walls of a vein, or the roof and floor of a coal bed, which more or less completely displaces the ore or coal. Called also Pinch-out (Standard). The narrowing of a vein or deposit. A thin place in a mineral zone or where the zone itself almost or quite disappears and in other places widens out into extensive

bodies of ore. (Meydenbauer *v.* Stevens. 78 Fed. Rept., p. 791)
2. A kind of crowbar for breaking down coal. (Gresley)
3. A kind of crowbar with a short projection and a heel or fulcrum at the end; used to pry forward heavy objects; a pinch. (Standard)
4. To move (heavy machinery, etc.) short distances at a time by means of short holds with a crowbar or pinch bar.

Pinch bar. *See* Pinch. 3.

Pinchbeck metal. An alloy of copper, 80, and zinc, 20 per cent. (Ure)

Pinchcock. A clamp on a flexible tube to regulate the flow of a fluid through the tube. (Webster)

Pinched. Where a vein narrows, as if the walls had been squeezed in. When the walls meet, the vein is said to be pinched out (Roy. Com.). *See* Pinching out; *also* Pinch, 1.

Pincher. In glass-making, a nipping tool for shaping at one operation the outside and inside of the neck of a bottle. (Standard)

Pinching out. *See* Pinch, 1.

Pinching tongs. In glass-making, a pair of tongs upon the extremities of whose jaws are two dies that, when closed, form a mold for ornamental pendants, which are thus made from molten glass. The eye in the end of a pendant is made by a pin between the jaws of the tongs. (Standard)

Pinch-out. *See* Pinch, 1.

Pin cracks (Leic.). Small fissures in coal seams filled with water and gas. (Gresley)

Pinder concentrator. A revolving table on which are tapering spiral copper cleats on a linoleum cover. The tailings are washed over the riffles and off the edge while the concentrates are delivered at the end of the riffles. (Liddell)

Pindy (Corn.). A carbonaceous shale. (Power)

Pinguite. A soft oil-green variety of the hydrous silicate chloropal. (Century)

Pin-in. To fill the interstices of masonry with small pieces of stone. (Standard)

Pinion. A cog wheel with a small number of teeth designed to gear with a larger wheel or rack. (Webster)

Pinite. A general term used to include a large number of alteration products of iolite, spodumene, nephelite, scapolite, feldspar, and other minerals. A hydrous silicate of aluminum and potassium. (Dana)

Pink ash (Penn.). An anthracite which, when burned, leaves a pink ash.

Pinning. 1. (No. Staff.) Bratticing in headings. (Gresley)
2. Small stones for filling in masonry interstices. (Webster)

Pino (Sp.). Pine. (Halse)

Pinta (Mex.). 1. Indication (by color, weight, or structure, etc.) of the metallic value of an ore; *P. de metal*, indications of ore, spots of ore. (Dwight)
2. *P. azul*, at Pachuca, Mex., the lower zone of the silver veins in which the matrix is either a gray or bluish color, due to the presence of silver sulphides. 3. (Venez.) A pay streak in gold placers. 4. A color in a *batea*. (Halse)

Pintar (Sp.). To exhibit indications of ore. (Halse)

Pinzas (Sp.) A tool for extracting small objects that have fallen down a bore hole. Pincers. (Halse)

Piojo (Sp. Am.). The last washing trough. (Lucas)

Pioneer (Corn.). An able pickman; a tin miner. (Pryce)

Pioneer bench. The first bench in a quarry which is blasted out. It is usually at the top of the rock to be quarried. (Bowles)

Pipage. 1. The carriage of oil, gas, water, etc., through pipes. 2. The charge for such carriage. (Standard)

Pipe. 1. An elongated body of mineral. A narrow portion of rich ore extending down the lode. 2. Also the name given to the fossil trunks of trees found in coal beds. (Ihlseng)
3. One of the vertical cylindrical masses of volcanic agglomerate in which diamonds occur in South Africa. 4. A tubular cavity, from a few inches to many feet in depth, occurring in calcareous rocks and often filled with gravel, sand, etc. 5. The eruptive channel opening into the crater of a volcano. 6. A tube for conveying water, oil, air, gas, etc. 7. A cavity in a casting, especially in an ingot of steel, due

to unequal contraction on solidifying. 8. To throw water upon from a hydraulic pipe. (Webster)

Pipeclay. 1. Masses of fine clay, generally of lenticular form, found embedded in the hydraulic gravel banks. (Hanks)
2. A highly plastic and fairly pure clay of a grayish-white color, used in making pipes, in calico printing, and for cleaning soldiers' accoutrements, etc. (Webster)

Piped air (Eng.). Ventilation carried into the working places in pipes. (Gresley)

Pipe dog. A hand tool that is used to rotate a pipe whose end is accessible, consisting of a small short steel bar whose end is bent at right angles to the handle, and then quickly returned, leaving only enough space between the jaws to slip over the wall of pipe. (Nat. Tube Co.)

Pipe grab. A clutch for catching and raising a well pipe. (Standard)

Pipe grip. In steam and pipe fitting an implement consisting of an iron bar with a curved end and provided with a chain of square links to hook on to the jaws of the curved end. *See* Chain tongs. (Nat. Tube Co.)

Pipe jack. An iron pipe with a clamp or pig foot upon one end and a curved point upon the other. It is wedged between the floor and roof of a mine room to hold the feed chain of a continuous electric coal-mining machine. (Steel)

Pipe line. A line or conduit of pipe, sometimes many hundred miles long, through which petroleum is conveyed from an oil region to a market or to reservoirs for refining (Standard). A line of pipe with pumping machinery and apparatus for conveying a liquid, or gas. (U. S. Min. Stat., pp. 1068–1073)

Pipeman. 1. A laborer or workman engaged in laying or repairing pipe. 2. A workman in charge of a pipe, especially in hydraulic mining. (Webster)

Pipe metal. An alloy of tin and lead, sometimes with zinc, for making organ pipes. (Webster)

Pipe opal. 1. (White Cliffs, N. S. W.) Opalized belemnites. 2. (Queensland) Long narrow cavities filled with opal. (Power)

Pipe ore. Iron ore (limonite) in vertical pillars, sometimes of conical, sometimes of hour-glass, form, imbedded in clay. Probably formed by the union of stalacites and stalagmites in caverns. (Raymond)

Pipe oven. A hot-blast oven in which the air passes through pipes exposed to the heat of burning gas in brick conduits. (Century)

Pipe press. The name commonly applied to the machine used for molding sewer pipe. (Ries)

Pipe-prover. An apparatus for testing the tightness of a pipe line or system, usually by hydraulic pressure. (Standard)

Piper (Lanc.). A feeder of gas in a coal mine. (Gresley)

Pipe sampler. A device for sampling a pile of ore, consisting simply of a small iron pipe which is driven into the pile and which, when withdrawn, brings a core of ore with it. (Richards, p. 845)

Pipestone. A kind of argillaceous stone, carved by the Indians into tobacco pipes (Webster). *See* Catlinite.

Pipe tongs. A hand tool for gripping or rotating pipe. (Nat. Tube Co.)

Pipette. 1. A small piece of apparatus for transferring fluids as in chemical operations. 2. To convey or draw off with a pipette. (Webster)
3. In ceramics, a funnel-like can to hold slip, and to permit it to escape in a fine stream, as in slip-decoration. (Standard)

Pipe vein (Derb.). An ore body of elongated form (Raymond). *See* Pipe, 1.

Pipe wrench. A wrench whose jaws are usually serrated and arranged to grip with increasing pressure as the handle is pulled. There are many forms such as Alligator, Stillson, Trimo, etc. (Nat. Tube Co.)

Piping (Cal.). 1. In hydraulic mining, discharging water from the nozzles on the auriferous gravel. (Hanks)
2. The tubular depression caused by contraction during cooling, on the top of iron or steel ingots (Raymond). *See also* Pipe, 7.

Pipos (Sp.). Temporary blindness due to bad ventilation of sulphur mines. (Halse)

Pique (Sp. Am.). A prospecting shaft; a winze. (Lucas)

Piqueador (Sp.). The man who strikes the drill. (Halse)

Piquera (Sp.). The tap hole of a blast furnace. *See also* Piqueta. (Halse)

Piqueta (Mex.). Tap hole; *P. de grasa*, a slag tap; *P. de plomo*, a lead tap (Dwight). *See also* Piquera.

Piquete (Mex.). Surveyor's stake on the surface; small prospect work of any kind. (Dwight)

Piquetero (Sp.). A boy who carries picks to workmen in mines. (Halse)

Piracy. The diversion of the upper part of a stream by the headward growth of another stream: also called Beheading, Stream capture, and Stream robbery. (La Forge)

Pirargirita (Sp.). Pyrargyrite. (Dwight)

Pirita (Sp.). Pyrite. *See* Bronce. (Dwight)

Pirn (Scot.). A flat-rope winding drum. (Gresley)

Pirolusita (Sp.). Pyrolusite. (Dwight)

Pirómetro (Sp.). Pyrometer. (Dwight)

Pirquín (Chile). Tribute. (Lucas)

Pirquinero (Chile). A tributor. (Lucas)

Pisanite. An iron sulphate in which part of the iron is replaced by copper, $(FeCu)SO_4+7H_2O$. (U. S. Geol. Surv.)

Pisar (Sp.) 1. To dip. 2. To beat down stones or earth with a mallet. 3. (Colom.) *P. el molino*, said of stamps when they pulverize ore in the battery. (Halse)

Piso (Sp.). 1. A floor or level. 2. The bottom working of a mine. 3. The footwall of a vein or deposit. (Halse)

Pisolite. A limestone composed of globular concretions, about the size of a pea. (Webster)

Pisolitic. Consisting of rounded grains like peas or beans. (George)

Pisón. 1. (Sp.) A rammer for driving earth, stone, or piles. 2. (Colom.) A stamp. 3. (Chile) A wet-crushing mill. (Halse)

Pissasphalt; Pissasphaltum. A soft bitumen of the consistency of tar, black, and possessing a strong smell (Mitzakis). *See also* Maltha.

Pisselaeum. A variety of bitumen. (Mitzakis)

Pistazite. A synonym for Epidote, more current in Europe than America, and used in rock names for epidote. (Kemp)

Pistola (Mex.). Small drill hole. (Dwight)

Pistol pipe. In metal working, the tuyère of a hot-blast furnace. (Century)

Pit. 1. (Eng.) A colliery; a mine shaft; a shallow hole. (Gresley)
2. The underground portion of a colliery, including all workings. Used in many combinations, as *pit* car, *pit* clothes, etc. (Steel)
3. In hydraulic mining, the excavation in which piping is carried on. (Hanks)
4. A stack of wood, prepared for the manufacture of charcoal. (Raymond)
5. A large hole from which some mineral deposit is dug or quarried, or the mine itself, as a gravel pit, stone pit. 6. A hole in the ground in which to burn something, as a lime pit, charcoal pit. (Webster)
7. An excavation in the earthen floor of a foundry to receive molten metal. (Standard)

Pit bank. 1. (Scot.) The surface of the ground at the mouth of a pit, or shaft. (Barrowman)
2. (Eng.) The raised ground or platforms upon which the coal is sorted and screened at surface. (Gresley)

Pit barring (Scot.). Timbers supporting the sides of a shaft. (Gresley)

Pit boss. One who has charge of the surface work at the mine as well as that in the mine. A mine foreman. (Steel)

Pit bottom. 1. (Scot.) The bottom or lowest landing in a shaft. (Barrowman)
2. (Eng.) The entrance to a mine and the underground roads, in the immediate vicinity, whether at the bottom of the shaft or at any point in it beneath the surface at which the cages are loaded. Also Pit eye. (Century)

Pit-bottom stoop (Scot.). A large solid block or pillar left around and to support the mine shaft. (Gresley)

Pit-brow (Lanc.). The pit bank (Gresley). At or near the top of a shaft.

Pit-car oil. *See* Summer black oil.

Pitch. 1. The ground assigned to tributers. 2. The dip or inclination of a vein or bed; more precisely, in modern usage, the inclination of an ore body in the direction of its strike. (Webster)
3. *See* Pitch of fold.
4. In dredging, the distance between the center of any pin and that of the pin in the next adjacent bucket. (Weatherbe, p. 66) 5. One of the residues formed in the distillation of wood or coal tar. It is also obtained from petroleum. The term 'pitch' is sometimes employed indiscriminately to mean bitumen or asphalt. (Mitzakis)
6. The amount of advance of a screw thread in a single turn, expressed in lineal distance along or parallel to the axis, or in turns per unit of length 7. The distance between tooth centers, measured on the pitch line, or the number of teeth per unit of diameter, as in a gear-wheel. (Standard)

Pitch-bag (Corn.). A bag covered with pitch, in which powder is inclosed for charging damp holes. (Raymond)

Pitchblende. *See* Uraninite.

Pitch coal. 1. A brittle lustrous bituminous coal or lignite. (Webster)
2. A kind of jet. (Standard)

Pitcher. 1. (No. of Eng.) A loader in the pit, and one who takes up and relays the rails at the working faces. (Gresley)
2. One who picks over dumps for pieces of ore. (Webster)

Pitcher brasses (Shrop.). Indurated schistose clay. (Gresley)

Pitcher molding. In ceramics, a method of molding by pouring thin slip into a mold, which is then emptied, leaving part of the mixture adhering. As it dries more is poured, to adhere and dry until the required thickness is obtained. (Standard)

Pitch-faced. In stone cutting, quarry-faced, but having the arris defined by a line beyond which the rock is cut away so as to give nearly true edges. (Webster)

Pitching. 1. The act of facing a bank with stone; also, the stone facing.
2. Rough paving of a street to a grade with coarse stone, or cobbles; a pavement so made. (Webster)

Pitching bar. A kind of pick used by miners in beginning a drill hole. (Webster)

Pitching chisel. In stone cutting, a steel chisel having the cutting face rectangular in outline. (Webster)

Pitching-stable. A Cornish paving granite. (Standard)

Pitch line. The line on which the pitch of teeth is measured; an ideal line, in a toothed gear or rack, bearing such a relation to a corresponding line in another gear with which the former works, that the two lines will have a common velocity as in rolling contact. (Webster)

Pitch of fold. The angle between the horizontal and an axial line passing through all the highest or lowest points of a given stratum of a syncline or anticline. (Lindgren, p. 112)

Pitch off. A quarryman's term for trimming an edge of a block of stone with a hammer and sett (Bowles). *See also* Pitch-faced.

Pitch ore. *See* Pitchy copper ore. Also a synonym for Pitchblende. (Chester)

Pitch mineral. Bitumen; asphalt. (Standard)

Pitch opal. An inferior quality of common opal. (Standard)

Pitch peat. A variety of peat resembling asphalt. (Standard)

Pitchstone. A variety of volcanic glass similar to obsidian but having a more resinous luster. (La Forge) It was formerly specially used for Pre-Tertiary glasses, *i. e.*, the glasses of quartz-porphyries and porphyries, but time distinctions are obsolete. Pitchstones have a marked resinous luster as the name implies. (Kemp)

Pitchy copper ore. An early name (Pecherz) for a dark-colored oxide of copper which looks like pitch. (Chester)

Pitchy iron ore. An old synonym for Pitticite. (Chester)

Pitchwork. In mining, work done on condition that the miner shall receive a certain proportion of the output (Standard). *See* Pitch, 1.

Pitch-workings. Mine workings in steeply inclined seams.

Pit coal. Coal obtained by mining, as distinguished from charcoal. (Power)

Pit committee (Ark.). A committee of mine workers elected by the local union to confer with the pit boss or superintendent in case of disputes between them and any miner. (Steel)

Pit crater. A volcanic crater at the bottom of a pit. (Standard)

Pit eye (Eng.). The bottom of the shaft of a coal mine; also the junction of a shaft and a level. (Raymond)

Pit-eye pillar. A barrier of coal left around a shaft to protect it from caving. (Raymond)

Pit frame. 1. The framework carrying the pit-pulley (Raymond). *See also* Head frame.
2. The framework in a coal-mine shaft. (Standard)

Pit gate (York.). Any place in the immediate vicinity of a colliery at which miners hold meetings of their own in reference to wages, etc. (Gresley)

Pit guide. An iron column that guides the cage in a mine shaft. (Standard)

Pith (Eng.). The soft part of the lode. (Hunt)

Pit head (Scot.). The landing at the top of a shaft. (Barrowman)

Pit head-frame (Scot.). *See* Head frame; Pit frame, 1.

Pit-head man (Scot.). The man in charge of the unloading of the cages and weighing of the mineral at a pit head. (Barrowman)

Pit heap (Eng.). *See* Heapstead.

Pit hill (Eng.). *See* Pit bank, 2.

Pit kiln. 1. A kiln sunk in the ground, as on a hillside. 2. An oven in which coke is made. (Standard)

Pit lamp; Pit light. An open lamp worn on a miner's cap as distinguished from a *safety lamp*. (Steel)

Pit man. 1. (Corn.) A man employed to examine the lifts of pumps and the drainage. 2. (Newc.) A working miner. (Raymond)

Pit mouth (Scot.). The opening of a shaft at the surface of the ground. (Barrowman)

Pitometer. In hydraulics, an instrument for autographically recording variations of flowing water. It consists essentially of two Pitot tubes, one pointed upstream and one downstream. (Webster)

Pitot's gauge. *See* Pitot's tube.

Pitot's tube. A tube bent at right angles, which inserted in a flowing stream receives the force of the current and measures its velocity by the rise of water in the vertical branch. (Standard)

Pit prop. A piece of timber used as a temporary support for the mine roof. (C. and M. M. P.)

Pit pumps (Scot.). Pumps used in a mine shaft. (Barrowman)

Pit rails (Eng.). Iron or steel rails upon which trams or tubs run in a mine. (Gresley)

Pit room. The extent of the opening in a mine; pit space. (Steel)

Pit rope (Eng.). Winding rope; a hoisting rope.

Pits (So. Wales). Long open-air fires for converting coal into coke for blast-furnace purposes. (Gresley)

Pit shaft (Eng.). Same as Shaft.

Pitter (Eng.). A horse or pony suitable for underground work. (Gresley)

Pitticite. Hydrous sulpharsenate of iron, found in yellowish, reddish, and brownish reniform masses (Chester). Also spelled Pittizite.

Pitting. 1. The act of digging or sinking a pit, as for sampling alluvial deposits. 2. Corrosion of metal by which small cavities are produced. 3. (Scot.). Mining on the outcrop by means of shallow pits.

Pit tip (Eng.). A bank or heap upon which mine waste is tipped or dumped. (Gresley)

Pit top. 1. (Eng.) The mouth of a mine shaft. Gresley)
2. (Aust.) The structure about the mouth of a shaft. (Power)

Pittsburgh flux. A condensed or blown oil from Ohio petroleum; it contains 97.6 per cent of bitumen soluble in carbon disulphide, 66.1 per cent of bitumen soluble in 88° Bé. naphtha, 55.5 per cent of pure bitumen as saturated hydrocarbons, 3.7 per cent of paraffin scale, 4.75 per cent of sulphur, and 13.7 per cent of ash-free residual coke. (Bacon)

Pit water (Aust.). The moisture contained in freshly mined coal, which is lost by exposure to ordinary atmospheric conditions. (Power)

Pit wood (Eng.). The timber used for propping the roof. (Gresley)

Pitwork (Corn.). The pumps and other apparatus of the engine shaft. (Raymond) *See also* Pit top.

Pit wright (Scot.). An engineer who attends to pit pumps, etc. (Barrowman)

Pivotal fault. *See* Fault.

Pivote (Mex.). The chimney of a small copper-smelting furnace. (Halse)

Pizarra (Sp.). Slate; *P. arcillosa*, a clay state; *P. carbonifera*, coal, slate or shale. (Halse)

Pizarral (Sp.). Slate quarry. (Lucas)

Pizarreña (Sp.). Slaty structure. (Dwight)

Placas (Mex.). Jaw plates for a crusher; *P. de cobre*, amalgamated copper plate; *P. de unión*, fish plate. (Halse)

Place. 1. *See* In place; *Also* In situ. 2. The part of a mine in which a miner works by contract is known as his "place" or "working place" (Steel). A point at which the cutting of coal, is being carried on. 3. (Eng.) A kind of cabin in which tools are kept in the mine, and in which a deputy eats his lunch. (Gresley)

Placer (Sp.). A place where gold is obtained by washing; an alluvial or glacial deposit, as of sand or gravel, containing particles of gold or other valuable mineral. In the United States mining law, mineral deposits, not veins in place, are treated as *placers*, so far as locating, holding, and patenting are concerned. Various minerals besides metallic ores have been held to fall under this provision, but not coal, oil, or salt. (Webster)

Placer claim. A mining claim located upon gravel or ground whose mineral contents are extracted by the use of water, by sluicing, hydraulicking, etc. (Duryee). The unit claim is 1,320 feet square and contains 10 acres. *See* Placer.

Ground with defined boundaries which contains mineral in the earth, sand, or gravel; ground that includes valuable deposits not fixed in the rock. (United States *v.* Iron Silver Mining Co., 128 United States, p. 679.) (U. S. Min. Stat., p. 507–517.) *See* Claim; *also* Lode claim.

Placer deposit. A mass of gravel, sand, or similar material resulting from the crumbling and erosion of solid rocks and containing particles or nuggets of gold, platinum, tin, or other valuable minerals, that have been derived from rocks or veins. (U. S. Geol. Surv., Bull. 613, p. 184)

Placer mining. That form of mining in which the surficial detritus is washed for gold or other valuable minerals. When water under pressure is employed to break down the gravel, the term *hydraulic mining* is generally employed. There are deposits of detrital material containing gold which lie too deep to be profitably extracted by surface mining, and which must be worked by drifting beneath the overlying barren material. To the operations necessary to extract such auriferous material the term *drift mining* is applied. (U. S. Geol. Surv., Bull. 259 p. 32). *See also* Dredge, 1.

Placing work (Eng.). The distribution of work among trammers (Bainbridge)

Plagihedral. In crystallography, having an oblique spiral arrangement of faces. (Webster)

Plagioclase. The triclinic feldspars are called collectively plagioclase. The principal triclinic feldspars are albite, anorthite, labradorite, and oligoclase. As constituents of rocks they occur generally in small crystalline grains, and without a microscopic examination it is difficult to distinguish them in this form from one another (Roy. Com.). A convenient designation for the feldspars consisting chiefly of silicates of sodium, calcium, and aluminum as opposed to those consisting chiefly of potassium and aluminum silicates. The name has reference to the oblique character of the cleavage of these feldspars as compared with orthoclase, the common potassium feldspar. (Ransome)

Plagioclastic. Having the cleavage of plagioclase; breaking obliquely. (Standard)

Plagionite. A sulphide of lead and antimony, of a blackish lead-gray color and metallic luster. (Webster)

Plain. An extent of level, or nearly level, land; a region not noticeably diversified with mountains, hills, or valleys. (Century)

Plain shale (Scot.). Oil shale not foliated. (Barrowman)

Plan. 1. The system on which a colliery is worked, as Longwall, Pillar-and-breast, etc. 2. A map or plan showing outside improvements and underground workings. (C. and M. M. P.)

Plan (Sp.). 1. The lowest working in a mine. 2. *P. del tiro*, the sump of a shaft. 3. An inclined plane. 4. A survey plan. 5. (Colom.) An artificial surface, slightly inclined, constructed on bedrock or sand for the deposition of alluvium. 6. (Colom.) A die or shoe of a stamp. 7. *Trabajar de plan*, to sink vertically or on an incline (Halse). *See also* Plano.

Planation. 1. The widening of valleys through lateral corrasion by streams after they reach grade and begin to swing, and the concurrent formation of flood plains. Also, by the extension of the above processes, the reduction of divides and the merging of valley plains to form a peneplain; peneplanation. 2. The grading of an area or district by any erosive process, either subaerial or marine. (La Forge)

Planch. A slab of fire brick in an enameling-furnace, to support the work while baking. (Standard)

Plancha (Mex.). 1. Pig, ingot, bar, plate, thick sheet, or mass of any metal. 2. Bucking board. 3. Mudsill. 4. Steel sheet. 5. Turnplate. 6. Amalgamating plate. 7. A charge of roasted ore weighing about 70 pounds. (Dwight)

Planchera (Mex.). Ingot mold of sand, earth, or iron. (Dwight)

Plancheta (Sp.). A plane table used in surveying. (Halse)

Planchuelas (Mex.). Fishplates. (Dwight)

Plane. 1. Usually applied to self-acting inclines, but any slope or incline on which coal is raised or lowered may be called a plane. (Chance)
2. A flat or level surface. (Webster)
3. (Scot.) A working room driven at right angles to or facing the joint planes. (Barrowman)
4. In brickmaking, a trowel-like tool for striking off clay that projects above the mold. (Standard)

Planear (Mex.). To extract gold from fissures, cracks, etc., in soft uneven bedrock. (Halse)

Plane course, or on plane (Scot.). In the direction facing the joint planes. (Barrowman)

Plane of symmetry. A plane to which a crystal is symmetrical; that is, for each face or angle of the crystal there is a similar face or angle in such position on the opposite side of the plane that the line joining the two faces or angles is perpendicular to the plane. (La Forge)

Plane surveying. Surveying in which the curvature of the earth is disregarded, as in ordinary field and topographic surveying. (Webster)

Plane table. 1. A simple surveying instrument by means of which one can plot the lines of a survey directly from the observations. It consists of a drawing board on a tripod, with a ruler, the ruler being pointed at the object observed. (Webster)
2. An inclined ore-dressing table. (Standard)

Planetesimal. One of numerous small solid planetary bodies which, according to the planetesimal hypothesis, had individual orbits about the sun and of which the planets were formed by aggregation. (La Forge)

Planetesimal hypothesis. The hypothesis that the earth, and the other planets, were formed by the collision and coalescence of planetesimals and have never been wholly molten. (La Forge)

Planilla (Mex.). 1. Inclined floor upon which tailings are washed. 2. Stationary buddle. 3. Sorting table. 4. Wooden skimmer for molten metal. (Dwight)
5. Packing or goaf. (Halse)

Planillero (Mex.). A workman on the *planilla*, always paid according to amount of concentrates produced. (Dwight)

Planimeter. An instrument for measuring the area of any plane figure by passing a tracer around the bounding plane. (Webster)

Planish. To condense, smooth, and toughen, as metal, by hammer blows. (Standard)

Planisher. A device by which to flatten thin sections cut for microscopic examination. (Standard)

Plank (So. Wales). Strata drained of gas. (Gresley)

Plank dam (Eng.). A water-tight stopping fixed in a heading, and constructed of plank placed across the passage. (Gresley)

Plank hook. In mining, a form of cant hook used for shifting planks. (Standard)

Plank-timbering. The lining of a shaft with rectangular plank frames. (Raymond)

Plank-tubbing. The lining of a shaft with planks, spiked on the inside of curbs. (Raymond)

Plano (Sp.). 1. A plan. 2. The floor of a mine working. 3. A plane; *P. inclinado*, an inclined plane; *P. de crucero*, in geology, a plane of cleavage; *P. de estratificación*, a plane of stratification; *P. de fractura*, plane of fracture; *P. de junta*, a joint plane. 4. *P. de resbalamiento*, a slickensides. 5. *P. de nivel*, a datum line (Halse). *See also* Plan.

Planophyre. A rock in which the phenocrysts are arranged in layers. (Iddings, Igneous Rocks, p. 224)

Plant. 1. The shaft or slope, tunnels, engine houses, railways, machinery, workshops, etc., of a colliery or other mine. (Steel)
2. To place gold or any valuable ore in the ground, in a mine, or the like to give a false impression of the richness of the property. To "salt," as to plant gold with a shotgun. (Webster) *See* Salting a mine.

Planté battery. A type of storage battery with both electrodes of lead and the electrolyte of sulphuric acid. (Webster)

Plasma. A variety of chalcedonic quartz. (Dana)

Plastering. Same as Mudcapping.

Plaster mill. 1. A machine consisting of a roller or set of rollers for grinding lime or gypsum to powder. 2. A mortar mill. (Century)

Plaster of Paris. A plaster made from gypsum by grinding and calcining it; so called from its manufacture near Paris in France. In Canada this term has been adopted for gypsum in any form (Roy. Com.). It forms with water a paste which soon sets, and is used for casts, moldings, etc.

Plaster pit (Derb.). A gypsum mine. (Gresley)

Plaster stone. Gypsum.

Plastic. Capable of being molded or modeled, as clay or plaster. (Webster)

Plasticity. The property possessed by clay of forming a plastic mass when mixed with water. (Ries)

Plat. 1. A floor for loading, unloading, etc., of ore, etc., at the junction of a shaft with a level (Webster). A platform.
2. A swinging or revolving door used intermittently to connect two trackways. (Ihlseng)
3. The map of a survey in horizontal projection, as of a mine, townsite, etc.

Plata (Sp.). Silver; *P. agria*, silver glance; *P. blanca*, native silver; *P. ceniza*, chloride of silver; *P. córnea amarilla*, iodyrite; *P. córnea blanca*, cerargyrite; *P. esponja*, silver sponge; *P. maciza*, (Peru), native silver, generally in small sheets; *P. mixta*, gold and silver alloy; *P. negra*, argentite; *P. niña*, silver bullion obtained by retorting amalgam, and not yet melted; *P. pasta*, silver bullion; spongy silver bars after retorting; *P. verde*, bromyrite; embolite. (Dwight)
P. de ley, standard silver. (Min. Jour.)

Plataforma (Sp.). 1. A platform, a scaffold. 2. A turn table. 3. A multiple-deck skip or "giraffe." (Halse)

Plate. 1. (Scot.) A flat cast-iron or malleable-iron sheet laid at the shaft bottom or at any landing to enable the cars to be easily turned and moved about. A cast-iron plate with a circular ridge on which cars are turned at junction of roads. (Barrowman)
2. (Eng.) Black shale; a slaty rock. (Hunt)
3. A sheet of rolled iron or steel a quarter of an inch or more thick. 4. To cover over with gold, silver, or other metal, either mechanically or chemically. (Webster)
5. Plate glass. 6. A horizontal timber laid on a wall to receive a framework. (Standard)
7. A sheet of copper coated with mercury for collecting gold. *See also* Amalgamation, 2.

Plate amalgamation. Amalgamation in which the crushed ore, suspended in water, is brought in contact with surfaces coated with a layer of mercury. (Clennell, p. 198)

Plate-and-frame filter press. A filter press consisting of plates with a gridiron surface alternating with hollow frames, all of which are held by means of lugs, on the press framework. The corners of both frames and plates are cored to make continuous passages for pulp and solution. The filter cloth is placed over the plates. The pulp passageway connects with the large square opening in the frame; the solution passageways connect with the gridiron surface of the plate. The Dehne and the Merrill are well-known types. (Liddell)

Plateau. An upland, tableland, or elevated plain having a fairly smooth surface and bounded, on at least one side, by an escarpment separating it from lower country. 2. A district or region of considerable extent and somewhat diverse surface, not dominantly mountainous but commonly including some mountains, which lies in general distinctly higher than the surrounding or adjacent country; an extensive upland region. 3. A formerly smooth upland or elevated plain now so much dissected that only traces of the former surface remain on flat-topped hills and ridges of nearly uniform altitude: more properly called a Dissected plateau. (La Forge)

Plate machine. An improved form of potters' wheel for forming porcelain plates for table use. (Standard)

Plate mark. A special mark put on articles made of precious metal to show the place of manufacture, fineness of the metal, etc. (Standard)

Plate metal. Refined iron run in molds and broken up for remelting or for use in a mix. (Webster)

Plate nail (Eng.). A nail or spike to fasten tram plates and rails to the sleepers. (G. C. Greenwell)

Plater. One who plates articles with a coating of precious or lustrous metals: usually in composition, as, a silver-plater. (Standard)

Platero (Sp.). A silversmith. (Dwight)

Plate oven. A double oven in one part of which the split cylinders of sheet or cylinder glass are heated before being flattened, the sheets then being placed in the other chamber to be annealed. (Webster)

Plate rail (Scot.). A flat cast-iron rail with a flange on one side. (Barrowman)

Plate roll. A smooth roll for making sheet iron or plate iron, as distinguished from one having grooves for rolling rails, beams, etc. (Standard)

Plate shale. A hard argillaceous shale. (Raymond)

Plate tongs. Tongs for grasping and handling iron or steel plates. (Standard)

Platform. 1. A wooden floor on the side of gangway at the bottom of an inclined seam, to which the coal runs by gravity, and from which it is shoveled into mine cars. 2. A scaffold. 3. A bench in a glass-furnace for receiving pots. (Standard)

Platillo (Sp.). 1. Scale pan. 2. A small cog wheel. 3. The small disk on a chain pump. 4. (Mex.) A red earthen plate for testing ore or slime. (Halse)

Platina. 1. Same as Platinum. 2. Twisted silver wire. (Standard)

Platina mohr. Same as Platinum black, which *see*. (Standard)

Plating. Art, or process, of covering anything with plates, or with a coating of metal. (Webster)

Plating hammer. A trip hammer for working on heavy metal plates for armored vessels. (Standard)

Platinic. Of, pertaining to, or containing platinum, especially in its higher valence; as, *platinic* chloride. *Compare* Platinous. (Standard)

Platiniferous. Containing or yielding platinum. (Standard)

Platiniridium. An alloy of iridium with platinum and other metals of that group, found native. (Standard)

Platinize; Platinate. To coat or combine with platinum, especially by electroplating. (Standard)

Platinocyanide. A cyanide of platinum and some other element or radical. (Standard)

Platinoid. 1. Resembling platinum. 2. An alloy of German silver and 1 or 2 per cent of tungsten, used in the manufacture of resistance coils and other electrical appliances. 3. A platinum metal. (Standard)

Platinous. Of, pertaining to, or containing platinum, especially in its lower valence (Standard). *Compare* Platinic.

Platinum. A heavy, almost silver-white metallic element, ductile and malleable, but very infusible and resistant to most chemical reagents. Melting point about 1,710° C. Symbol, Pt; atomic weight, 195.2; specific gravity, 21.4 (Webster). Practically all platinum is found in the metallic state, though small quantities are obtained from sperrylite (*which see*) and in the electrolytic refining of copper. (U. S. Geol. Surv.)

Platinum black. A soft, dull-black powder of metallic platinum, obtained by reduction and precipitation from its solutions. (Webster)

Platinum luster. A silvery luster given by a platinum glaze, more commonly known as Silver luster. (Standard)

Platinum metals. The group of metallic elements which in their chemical and physical properties resemble platinum. They are rhodium, ruthenium, and palladium whose specific gravities are about 12, and osmium, irridium and platinum whose specific gravities are over 21. (Webster)

Platinum sponge. Metallic platinum in gray, porous, spongy form, obtained by reducing the double chloride of platinum and ammonium. It occludes oxygen, hydrogen and other gases, to a high degree and is employed as an agent in oxidizing. (Webster)

Platinum yellow. A pigment consisting of an alkaline chloroplatinate. (Webster)

Platón (Sp.). A small pan used for ore washing. (Halse)

Platt (Corn.). An enlargment of a level near a shaft, where ore may await hoisting, wagons pass each other, etc. (Raymond). Same as Plat, 1.

Platten. In glass-making, to flatten out; make into sheets or plates; specifically, to make (a blown cylinder) into a sheet by cutting lengthwise and softening so that it opens out. (Standard)

Platting. Brick laid flatwise on top of a kiln to keep in the heat. (Ries)

Plattnerite. Lead dioxide, PbO_2. Rarely in prismatic crystals, usually massive. Luster, submetallic. Color, iron-black. (Dana)

Plattner's process. A process for extracting gold in which a charge of gold-bearing pulp is placed in a revolving iron drum lined with lead, and a stream of chlorine gas is conducted through the pulp, producing chloride of gold, which is soluble in water (Goesel). *See* Chlorination process.

Play. 1. (No. of Eng.) To work a steel mill. *See* Steel mill. 2. Idle, said of a mine not at work. *See* Play day (Gresley)

Playa (Sp.). 1. A shore, strand, beach, or bank of a river. Generally sandy, and sometimes auriferous. (Halse)
2. The shallow central basin of a desert plain, in which water gathers after a rain and is evaporated. (U. S. Geol. Surv., Bull. 613, p. 184)

Play day (Eng.). A day on which, on account of accident, or other causes, mines are not worked (Gresley). *See* Play, 2.

Player (Eng.). A man who formerly worked a steel mill (Gresley). *See* Steel mill.

Playero (Peru). One employed in gold washing. (Halse)

Play-in (Leic.). To commence holing or undercutting a face of coal at the side of a heading. (Gresley)

Plaza (Sp.). 1. Room or space. 2. The bottom of a shaft furnace; the floor or bed of a reverberatory furnace. (Halse)

Plaza miner (Mex.). Any one who spends much of his time at a plaza, hotel lobby, etc., talking of prospects, mines, and mining operations.

Plazo (Sp.). The term of a bond or refusal of a mining property (Halse). An option.

Plegar (Sp.). To fold, as of geological strata. (Halse)

Pleiocene. *See* Pliocene.

Pleistocene. The earlier of the two epochs comprised in the Quarternary period, in the classification generally used. Also called Glacial epoch and formerly called Ice age, Post-Pliocene, and Post-Tertiary. Also the series of sediments deposited during that epoch, including both glacial deposits and ordinary sediments. Some geologists formerly used Pleistocene as synonymous with Quarternary and included in it all post-Tertiary time and deposits. (La Forge)

Pleito (Sp.). A lawsuit. (Min. Jour.)

Pleochroic. Exhibiting several different colors or tints when looked through in different directions. (Butler)

Plenum. A system of ventilation in which air is forced into an inclosed space, as a room or a caisson so that the outward pressure of air in the space is slightly greater than the inward pressure from the outside, and leakage is outward instead of inward (Webster). A mode of ventilating a mine or a heading by forcing fresh air into it. (Gresley)

Pleochroism. The property of colored double-refracting minerals whereby light penetrating in different directions shows different colors. (Power)

Pleomorphism. The property of crystallizing under two or more distinct fundamental forms. (Webster)

Pleonaste. Same as Ceylonite.

Plesiomorphism. The property of certain substances of crystallizing in similar forms while unlike in chemical composition. Called also Isogonism. (Standard)

Plicated. Folded together, as in highly inclined and contorted strata. (Roy. Com.)

Pliegue (Sp.). A fold or slip. (Halse)

Plies (Scot.). Successive thin layers of coal or rock. (Gresley) *See also* Ply.

Pliocene. The latest of the epochs comprised in the Tertiary period, in the classification generally used. Also the series of strata deposited during that epoch. (La Forge)

Plodding (Scot.). Uncertain; irregular, *i. e.*, a plodding band or seam of ironstone. (Barrowman)

Plomada (Mex.). Plumb line, or plumb bob. (Dwight)

Plomero (Mex.). 1. A lead tapper; a furnace man. 2. Plumber. (Dwight)

Plomillos (Mex.). 1. Shots of lead found in slag. (Dwight)
2. At San Luis Potosi, Mex., tin ore in which hematite predominates, or is present in equal proportions. (Halse)

Plomo (Sp.). 1. Lead; *P. afinado*, refined lead; *P. agrio*, slag lead, hard lead; *P. de obra*, argentiferous lead, base bullion; *P. pobre*, lead poor in silver. 2. (Mex.) Lead ore, generally galena. 3. *P. ronco* (Peru), argentite. (Halse)

Plot. 1. A surveyor's or engineer's map of a piece of ground; a chart, plan, or geographical representation.
2. To locate on a map or chart, as a point, curve, diagram, or plan; represent graphically; make a map or chart of (Standard). *See* Plat.
3. (Corn.) "To cut a plot" is to make room, or square out a piece of ground by the side of the lode or shaft, for holding the broken ore or waste for other convenient purposes. (Pryce)

Plotting scale. A scale used for setting off the lengths of lines in surveying. (Century)

Plow steel. A high-tensile steel first used in rope for plowing fields. Now widely used in the manufacture of hoisting ropes.

Pluck. To tear away projecting pieces of rock; said of the action of glaciers on contiguous rock. (Standard)

Plucking. The disruption of blocks of rock by a glacier. (Standard)

Plucky. A term applied to stones that, under the chisel, break away in irregular conchoidal chips, thus making it difficult to secure a smooth face. (Gillette, p. 6)

Plug. 1. A mass of igneous rock formed in the vent of a volcano. Dome, spine, or aiguille. (Daly, p. 130)
2. In surveying, a reference peg driven flush with the ground. (Webster)
3. A hammer closely resembling the bully. (Raymond)
4. *See* Plug-and-feather.

Plug-and-feather. The plug is a wedge and the feathers are two short pieces of half-round iron whose curved sides fit the sides of a drill hole while their flat sides receive the plug. By driving the plugs in a series of holes, a stone may be broken. (Gillette, p. 541)

Plug box (Eng.). A wooden water-pipe used in coffering. (Gresley)

Plug drill. A stone cutter's percussion drill. (Webster)

Plugged crib (York). A walling crib carried by iron plugs (two to each segment) fixed in the wall rock. (Gresley)

Plugging. 1. The stopping of the flow of water into a shaft by plugs of clay. (C. and M. M. P.)
2. (Eng.). Supporting a crib upon iron bars fixed in the wall of a shaft. (Gresley)
3. (Scot.). Blasting by means of plug shots. (Barrowman)

Plug hole. Same as Block hole. (Du Pont)

Plugman (Newc.). The man in charge of the pumping engine. (Min. Jour.)

Plug shot (Scot.). A small charge exploded in a hole to break up a stone of moderate size. (Barrowman)

Plum. An old form of plumb.

Plumb. 1. Vertical. 2. A plumb bob; a plummet. (Webster)
3. To carry a survey into a mine through a shaft by means of heavily weighted fine wires hung vertically in the shaft. The line of sight passing through the wires at the surface is thus transferred to the mine workings. An important piece of work in mine shafts, and in transferring courses or bearings from one level to another.

Plumbagina (Sp.). Graphite. (Halse)

Plumbing; Plumming. *See* Plumb, 3.

Plumbaginous. Containing plumbago, as plumbaginous schists; some crystalline limestones are also plumbaginous. (Roy. Com.)

Plumbago. The mineral graphite chiefly used in the manufacture of pencils, etc.; more commonly known as black lead, and very often wrongly thought to be lead by its resemblance to it (Skinner). Also used as a lubricant.

Plumbean. Consisting of or resembling lead. (Standard)

Plumbeous ware. In ceramics, earthenware with a lead glaze. (Standard)

Plumbic. Of, pertaining to, or containing lead, especially in its higher valence; as *plumbic* chloride. (Standard)

Plumbic ocher. Same as Massicot. (Standard)

Plumbiferous. Producing, or containing lead. (Webster)

Plumbism. Lead poisoning. (Standard)

Plumb line. A line or cord having at one end a weight, usually conoidal and of brass or lead, used to determine verticality; a plummet; a sounding line. (Webster) Used in mine-shaft plumbing. *See* Plumb, 3.

Plumbocalcite. A variety of calcite containing a small amount of lead carbonate. (Century)

Plumbogummite. A hydrous phosphate of lead and aluminum. (Century)

Plumbojarosite. A hydrous sulphate of lead and iron, $PbFe_6(OH)_{12}(SO_4)_4$. (U. S. Geol. Surv.)

Plumbous. Of, pertaining to, or containing lead, especially in its lower valence, as *plumbous* chloride. (Standard)

Plum-bulking (Scot.). The full dip of the coal seam. (Gresley)

Plumbum (L.). Lead; so called in pharmacy and old chemistry. (Standard)

Plum-hatching (Scot.). The full rise of a coal bed. (Gresley)

Plummet. *See* Plumb line.

Plumos antimony. An early name for jamesonite, which is also called Feather ore. (Chester)

Plumose. Having a feathery appearance (Thompson)

Plumose mica. A variety of muscovite mica. (Power)

Plumosite. A synonym for Jamesonite. (Chester)

Plump (Corn.). A corruption of the word pump. (Pryce)

Plump hole (Scot.). A hole at the surface caused by the extraction of mineral from underneath. (Barrowman)

Plum-pitch (Brist.). The full rise or full dip of the strata. (Gresley)

Plum-pudding stone. Pudding stone; a conglomerate. (Webster)

Plunge. 1. In surveying, to set the horizontal cross wire of a theodolite in the direction of a grade. 2. To turn over the telescope of a transit on its horizontal transverse axis. (Webster)
3. Called pitch or rake by many authors. Applied to ore bodies, is the vertical angle between a horizontal plane and the line of maximum elongation of the body. (Lindgren, p. 142)

Plunge a grade. To establish a grade between two points of known level by sighting the target, set up at either point, through a theodolite fixed at the other point, clamping and setting the instrument, and then bringing the target into the fixed line of sight at any desired intermediate point on the grade. (Webster)

Plunge pole; Plunger pole (Eng.). The piston- or pump-rod of a pumping-engine; a plunger. (Standard)

Plunger. 1. The piston of a force-pump. (Raymond)
2. A tank in which the clay and other ingredients are worked with water to the proper consistency. 3. A reckless gambler or speculator. (Webster)
4. In blasting, a rod designed for thrusting into a drill hole and ascertaining the position of the cartridge. (Standard)

Plunger bucket. A piston, without a valve, in a pump. (Webster)

Plunger case. The pump barrel, or cylinder, in which a solid piston or plunger works (Gresley). Also called Pole case.

Plunger lift (Scot.). A pump and column of pipes attached, raising water by means of a ram or piston. (Barrowman)

Plunge rod. A level rod used in surveying. (Webster)

Plunger pump. A pump having a solid reciprocating piston instead of one with a valve, usually one in which such solid piston is of considerable length as compared with its diameter. (Standard)

Plush copper; Plush copper ore. A Cornish name for chalcotrichite, probably alluding to its appearance. A fibrous red oxide copper mineral. (Dana)

Plus sight. *See* Back sight.

Plutonic. Of igneous origin. A general name for those rocks that have crystallized in the depths of the earth, and have therefore assumed, as a rule, the granitoid texture. (Kemp)

Pluvial. In geology, due to the action of rain. (Webster)

Ply (So. Staff.). A thin bed or band of shale, etc., lying immediately over a coal seam (Gresley). *See also* Mining ply.

Pneumatic drill. A drill of either the reciprocating or hammer type operated by compressed air.

Pneumatic hoist. A device for hoisting, operated by compressed air. (Standard)

Pneumatic jig. A jigging machine in which an air blast performs the work of separation of minerals. (Standard)

Pneumatics. The branch of physics that treats of the mechanical properties of gases, such as their pressure, elasticity, density, and also of pneumatic mechanism. (Standard)

Pneumatogenic. In geology, derived from or modified by substances in a gaseous condition; said of ores and other mineral deposits: contrasted with Hydatogenic. (Standard)

Pneumatolysis. The alteration of rocks and the formation of minerals during or as a result of the emanation of gases and vapors from solidifying igneous rocks. (La Forge) The chief gas concerned is water, under such conditions both of high temperature and high pressure that it is a true gas. (Shamel, p. 136)

Pneumatolytic. Characteristic of, pertaining to, or formed during pneumatolysis. (La Forge) A general name applied to those minerals that have been produced in connection with igneous rocks through the agency of the gases or vapors called mineralizers. They may be in the igneous mass itself or in cracks in the wall rock. The term is much used in discussions of ore deposits. (Kemp)

Pneumonaconiosis. A disease of the lungs due to habitually inhaling minute mineral or metallic particles, as of coal dust in Anthracosis; Miner's asthma, or Miner's lung. (Webster)

Poblador (Mex.). 1. Shift boss. 2. The miner who points the holes. (Dwight)

Poblar (Mex.). To set men at work in a mine. (Dwight)

Pobre (Sp.). Barren, sterile; said of rocks, veins, etc. Low-grade ore or metal. (Halse)

Poção (Braz.). Pits in river beds in which diamond-bearing gravel is found. (Halse)

Pocket. 1. A small body of ore; an enlargement of a lode or vein; an irregular cavity containing ore. 2. A natural underground reservoir of water. 3. A receptacle, from which coal, ore, or waste is loaded into wagons or cars. (Raymond)
4. A ganister quarryman's local term for masses of rock 30 to 50 feet in width that are worked out and loaded, buttresses of untouched rock being left between them to support the upper masses. (Bowles)
5. A hole or depression in the wearing course of a roadway. (Bacon)
6. A glen or hollow among mountains. (Century)

Pocket hunter. A term used in California for a miner or prospector who searches for small gold deposits which occur on the surface in the Mother Lode and other districts of the State.

Pockety. Containing only occasional bunches of good ore. (Weed)

Poço (Braz.). 1. A well. 2. A shaft. *See also* Pozo. (Halse)

Pocono sandstone. A sandstone of the Mississippian system in the northern Appalachians, especially in Pennsylvania. It is oil-and-gas bearing in West Virginia, and is called by the drillers Big Injun sand. (Webster)

Poder (Corn.). Refuse copper ore (Standard). Sometimes spelled Podar.

Podrir jaguas (Colom.). To expose concentrates to the air in order to oxidize the sulphur, and thereby facilitate the extraction of the gold. (Halse)

Poicilitic. *See* Poikilitic.

Poikilit; Poikilopyrite. Same as Bornite.

Poikilitic. Having small crystals lying in all positions in larger crystals of another mineral; said of the fabric of some igneous rocks. (La Forge) A term proposed by G. H. Williams for those rocks which have mottled luster, because on the shining cleavage faces of some of their minerals small inclusions of others occur, producing the effect. The same thing was earlier called "luster mottling" by Pumpelly, but poikilitic has proved a useful term both in megascopic and microscopic work. It is also spelled poicilitic and poecilitic. (Kemp)

Point. 1. The tapering end of anything pointed, as of a needle, pencil, etc. 2. The tapering end of a tract of land; also a peak. 3. A stonecutter's tool with a pyramidal end used to smooth down rough surfaces.
4. A tapering rail, as in a frog or switch. 5. A pointed steam pipe used in a system of thawing frozen ground in sinking a shaft. 6. To finish a wall by filling the joints with cement or mortar. (Webster)
7. (Eng.) The bearing or direction, in reference to the magnetic meridian, in which an underground road is driven. (Gresley)
8. In quarrying, a type of wedge that tapers to a narrow, thin edge. (Bowles)
9. The end or bottom of a bore hole, as distinguished from the mouth or collar. (Du Pont)

Pointed box. A box, in the form of inverted pyramid or wedge, in which minerals, after crushing and sizing, are separated in a current of water (Raymond). *See* Spitzkasten.

Pointer. In masonry, a tool for clearing the mortar from old joints in order to point them (Standard). *See* Point, 6.

Point of the horse. The point where a lode splits or divides into two parts. (Whitney)

Point out. Said of a well in which the bore of the hole becomes reduced to a size too small to permit further work.

Poison tower. A chamber in which the fumes of sulphur and arsenic are condensed in the manufacture of arsenic in Saxony and Silesia. (Standard)

Poker. *See* Picker.

Pokkers and jetters (Eng.). Blocks or pulleys, which carry or support the connecting rods of pumps or engines. (Pryce)

Polar glacier. A glacier formed in the high latitudes. (Chamberlin, vol. 1, p. 239)

Polariscope. An instrument for studying the properties of, and examining substances in polarized light. (Webster)

Polarization. The process by which ordinary light is changed into polarized light. The plane at right angles to the plane of transverse vibration is called the plane of polarization. (Dana)

Polarized. Changed from the ordinary state, in which the transverse vibrations occur in all planes passing through the line of propagation, to a state in which they are in a single plane: said of light under certain conditions, especially when passed through a doubly refracting crystal. (La Forge)
Polarized light is used to distinguish minerals, particularly colorless, transparent ones, under the microscope.

Polarizer. That one of the two Nicol prisms in a polarizing microscope through which the light passes before reaching the mineral section which is being examined. (La Forge)

Polders (Dutch). Low fertile lands, reclaimed by vast systems of dikes and embankments from the sea. (Page)

Pole. 1. Either extremity of an axis of a sphere. (Webster)
2. In glass-making, to work (as molten glass) with a pole, to diminish the lilac color due to the presence of a low manganese oxide.
3. To work, as molten copper, with a pole to lessen the amount of copper oxide present. *See* Poling, 2. (Standard)

Polea (Sp.). Pulley wheel, or sheave. (Halse)

Pole case (Eng.). *See* Plunger case.

Pole chain. A surveyor's chain. (Standard)

Pole drill. In well boring, a system where a rigid connection is used between the drilling tools and the reciprocating beam. (Nat. Tube Co.)

Pole piece. A mass of iron forming the end of an electromagnet, by means of which the lines of magnetic force are concentrated and directed. (Century)

Pole tools. The tools used in drilling with rods. *See* Cable tools. (Raymond)

Policeman (Scot.). A movable guard over or around a shaft mouth or at mid-workings; safety gates. (Barrowman)

Poling. 1. Stirring a metallic bath (of copper, tin, or lead) with a pole of green wood, to cause ebullition and deoxidation in the refining process. (Raymond)
2. The act or process of temporarily protecting the face of a level, drift, cut, etc., by driving poles or planks along the sides of the yet unbroken ground (Webster). Used especially for holding up soft ground. *See also* Forepoling.

Polings. Poles used instead of planks for lagging. (Raymond) Also spelled Pollings.

Polishing bed. An apparatus in which stone slabs, etc., are rubbed smoth, usually with felt-covered blocks charged with a powder. (Standard)

Polishing cask. A barrel in which grained gunpowder is tumbled with graphite to glaze it. (Standard)

Polishing mill. A lap of metal, leather, or wood used by lapidaries in polishing gems. (Century)

Polishing oil. A term applied to that fraction, having a boiling point of 130° to 160° C., obtained in refining petroleum. (Bacon)

Polishing slate. A gray or yellow slate, consisting of siliceous organisms, used for polishing; found chiefly in the coal measures of Bohemia and in Auvergne, France. (Standard)

Polishing snake. A serpentine found near the Ayr, in Scotland, used formerly in polishing lithographic stones. (Standard)

Polishing stone. Polishing slate. (Standard)

Polissoir. In glass-making, a hardwood block with a long iron handle by which to flatten glass cylinders newly opened out; a flattener. (Standard)

Poll. 1. (Corn.) The head or striking part of a miner's hammer. (Raymond)
2. (So. Wales). To clean the shale off ironstone. (Gresley)

Pollos (Peru). Small bags of rich ore given by the miners, on Saturdays, to the proprietors. (Halse)

Poll pick. A pick with a head for breaking away hard partings in coal seams or knocking down rock already seamed by blasting. (Raymond)

Pollucite. Hydrous cæsium-sodium-aluminum silicate, $H_2O.(Cs,Na)_2O.Al_2O_3.5SiO_2$. Found in pegmatite. (U. S. Geol. Surv.)

Pollux. Same as Pollucite. (Standard)

Polrose. Same as Polroz.

Polroz (pronounced polrose). (Corn.). The pit underneath a water wheel. (Raymond)

Polstean (Corn.). A tin pit. (Davies)

Polvillo (Sp. Am.). 1. Rich, black silver sulphide concentrates, obtained in the patio process. 2. *P. buenos*, good ore; the richest ore. (Halse)

Polvillos (Mex.). Rich concentrates, or very high-grade ores. (Halse)

Polvo (Mex.). Dust; flue dust; *P. de carbón*, coal-dust. (Halse)

Pólvora (Sp.). Gunpowder. In Spanish America, a miner's term for any blasting material; *P. de algodón*, guncotton (Halse). *P. de mina*, any powder used in mining. (Lucas)

Polvorero (Sp.). Powder man; powder monkey. (Halse)

Polvorillas. 1. (Peru) Decomposed sulphide of silver (Dwight). 2. (Mex.) Altered marcasite containing some gold. 3. *Estaño de p.* (Durango, Mex.), tin ore penetrating the country rock. 4. (Chile) A ferruginous pulverulent copper ore, phillipite. (Halse)

Polvorin (Sp.). A powder magazine. (Halse)

Polybasite. Sulphide of silver and antimony, Ag_9SbS_6. If pure, it would contain 75.6 per cent silver, but copper replaces part of the silver; also arsenic replaces antimony. (U. S. Geol. Surv.)

Polychromatic. Showing a variety, or a change of colors. (Webster)

Polycrase. A columbate and titanate of yttrium, erbium, cerium, and uranium, with some iron and water. (U. S. Geol. Surv.)

Polydymite. A nickel sulphide, perhaps Ni_4S_5. (Dana)

Polygenetic. Originating in various ways or from various sources; formed at different places or times or from different parts; said specifically, in geology, of mountain ranges; opposed to Monogenetic. (Standard)

Polygenous; Polygenic. Composed of or containing several different kinds of material; heterogeneous in composition; as polygenous conglomerate. (Standard)

Polygonal masonry. Masonry formed of polygonal stones, or of stones strictly not coursed, whose joints exhibit any other than a right angle, but which are carefully fitted together. (Standard)

Polylith. A megalithic structure of several or many stones, as a dolmen or stone circle, and dating from Neolithic times. (Webster)

Polymeric. Having the same elements united in the same proportions by weight, but with different molecular weights. (Webster)

Polymerize. To change into another substance having the same elements in the same proportions, but a higher molecular weight. (Webster)

Polymnite. A stone marked with dendrites and black lines, that have a fancied resemblance to rivers, marshes, and ponds. (Standard)

Polymorph. A substance crystallizable in several distinct forms; also any one of these forms. (Webster)

Polymorphism. The property of having or presenting many forms; especially in crystallography, the ability of certain substances to crystallize with different axial ratios without change of chemical composition: thus, carbon as diamond crystallizes in the isometric system, and as graphite in the hexagonal system. (Standard)

Polyphase. In electricity, having or producing two or more phases, as a polyphase current (Webster). Same as Multiphase.

Polysomatic. Having a texture consisting of numerous small grains: said of minerals. (Standard)

Polysynthetic twinning. *See* Oscillatory twinning.

Polytelite. A silver-lead tetrahedrite found in Germany. (Standard)

Polyxen. An old synonym for platinum because so many other metals occur with it. (Chester)

Pómez (Sp.). Pumicestone. (Halse)

Pompeiian brick. A loosely used term, but it is probably most frequently applied to bricks 12 by 1½ by 4 inches in size, of medium dark shade, with a brownish body covered with iron spots. (Ries)

Poncelet wheel. A kind of undershot water wheel suitable for falls of less than six feet, having the buckets curved so that the water presses on them without impact. (Webster)

Ponding. The natural formation of a pond or lake in a watercourse; chiefly: (*a*) by a transverse mountain uplift whose rate of elevation exceeds that of the stream's erosion, or (*b*) by a dam caused by glaciers, volcanic ejecta, landslips, or alluvial cones or stronger streams. (Standard)

Pondlet. A little pond; in geology such a pond formed by ponding. (Standard)

Poner (Sp.). To put, to place; *P. en marcha*, to start to blow in a furnace; *P. en obra*, to construct, to build; *P. en principal*, to compel a stream of water to flow as straight as possible; *P. puerta* (Colom.), to timber an adit. (Halse)

Pongo (Ecuador). A narrow and dangerous pass in a river; a ford. (Halse)

Poriente (Mex.). West. *See* Oeste. (Dwight)

Ponsard furnace. A furnace in which the escaping combustion gases, passing through tubular flues, heat the incoming air continuously through the flue-walls. (Raymond)

Pontil. An iron rod used in glass-making to carry and manipulate hot bottles, etc., and having a projection at the end varying in shape according to the character of the ware carried. Called also Snap; Pontee; Ponto; Ponty; Puntee; Puntil; Punty. (Standard)

Ponty sticker. A workman who fixes a quantity of blown glass to the ponty or pontil. *See also* Pontil. (Century)

Pony putter (No. of Eng.). A boy who drives a pony in the mine workings.

Pood. A Russian weight of 36.113 pounds avoirdupois. (Webster)

Pool. 1. To cut; to insert a wedge for splitting; to undercut or undermine, as in excavating coal. 2. A belt of oil-producing territory (Webster). An oil or gas deposit occurring under a dome. *See* Dome, 5.

Poor rock (Mich.). The more or less barren part of the material taken down in mining. (Sanders, p. 89)

Pop. A short bore hole drilled in a large rock with a view to reducing the size of the rock by means of a small explosive charge (Skinner). Also called Pop hole; Pop shot.

Pop a bowlder. To place and explode a stick of dynamite on a bowlder so as to break it for easy removal from the mine. (Batesell *v.* American Zinc, Lead, etc., Co., 190 Missouri App., p. 235)

Pop hole. A secondary drill hole. (Bowles). *See* Pop.

Popo (Afr.). A green jasper highly prized in Guinea, perforated beads of it passing as money. (Standard)

Poppet; Puppet. 1. A pulley frame or the headgear over a shaft. A head-frame. 2. A valve that lifts bodily from its seat instead of being hinged. (Ihlseng)

Poppet head (Corn.). A timber frame over a shaft to carry the hoisting pulley (Raymond). A head-frame.

Poppet leg (Eng.). Any of the supporting legs of a poppet head. (Webster)

Pop shot. Same as a block-hole shot. (Du Pont) *See also* Pop.

Porcelain. A translucent kind of pottery, usually glazed, existing in many varieties, according to its composition and method of manufacture, but generally characterized by a glassy fracture, clear ring when struck, homogeneity throughout its thickness, and resistance to fire, water, and acids but hydrofluoric. Porcelain includes chiefly three varieties: (*a*, Hard porcelain, (*b*) natural soft porcelain, and (*c*) artificial soft porcelain. (Standard)

Porcelain clay. *See* Kaolin.

Porcelain color. A pigment such as is used in decorating porcelain. (Standard)

Porcelain gilding. A process of applying gold to china, usually with turpentine, and firing it, resulting in the adherence of the metallic gold to the china and the volatilization of the less permanent ingredients. The gold is then burnished. (Standard)

Porcelainite. A trade term for white stoneware, jasper, etc. (Standard)

Porcelainized. Resembling potter's clay that has been fired; specifically, in geology, applied to certain altered clays, shales, etc., which by the influence of heat have come to resemble clay ware or porcelain. (Standard)

Porcelain jasper. Burnt clay (Power). *See* Porcellanite.

Porcelain lace. A decorative material formed by soaking lace in porcelain slip and firing it. The threads of the fabric are consumed, leaving the pattern in a fine lace-like porcelain-ware. (Standard)

Porcelain mill. A mill for grinding materials for porcelain. (Standard)

Porcelain oven. The firing kiln used in baking porcelain. (Century)

Porcelain printing. The transfer of a printed picture to an unglazed article. (Standard)

Porcellanite. Fused shales and clay, that occur in the roof and floor of burned coal seams. The rock is quite common in the lignite districts of the West, where apparently spontaneous combustion has fired the seams in the past (Kemp). Called also Porcelain jasper, especially when red. (Standard)

Porch (York.). The arching of the station or landing at the bottom of a shaft. (Gresley)

Pórfido; Pórfiro. 1. (Sp.) Porphyry, *P. traquito*, trachyte porphyry. 2. (Venez.) A kind of hornstone sometimes becoming jasper. (Halse)

Porodic. Of, or pertaining to, uncrystalline or amorphous substances: a term proposed as a synonym for colloid by T. Sterry Hunt in "Systematic Mineralogy." (Standard)

Porodine. Breithaupt's name for amorphous rocks, such as are derived from gelatinous silica. (Kemp)

Porodite. Wadsworth's name proposed in 1879 for all the altered, fragmental forms of eruptive rocks, commonly called diabase tuff, schalstein, etc. (Kemp)

Porosity. The state or quality of being porous. The volume of pore space expressed as a percentage of the total volume of the rock mass.

Porronguito (Peru). A crude quicksilver measure. (Dwight)

Por pie (Mex.). The *patio* process. (Dwight)

Porpezite. A native alloy of argentiferous gold with palladium, the palladium content varying up to 10 per cent (Dana). Called also Palladium gold. From Porpez, Brazil.

Porphyrite. Any granophyric igneous rock containing phenocrysts of alkali-calcic plagioclase; diorite porphyry. (La Forge) To distinguish it from andesite, it is necessary to draw a contrast between surface flows (andesites) and intruded dikes or sheets (porphyrites); or between Tertiary and later lavas (andesites) and Pre-Tertiary ones (porphyrites); or between those with glassy or very finely crystalline groundmasses (andesites) and those with groundmasses of moderate coarseness (porphyrites). (Kemp)

Porphyritic. A textural term for those rocks which have larger crystals (phenocrysts) set in a finer groundmass, which may be crystalline or glassy, or both. Ro enbusch has sought to define it as the texture due to the recurrence of the period of crystallization of the same or similar minerals. While, except for porphyritic rocks with a glassy groundmass, this practically amounts to the same thing as the textural definition just given; it is idle for any writer to try to change so old, well-established and indispensable a conception. (Kemp)

Porphyrization. The process of porphyrizing, or the state of being porphyrized. (Standard)

Porphyrogenetic. Producing porphyry. (Standard)

Porphyroid. Metamorphic rocks with porphyritic texture, *i. e.*, with phenocrysts of feldspar or other minerals in a finer groundmass, yet shown by geological relations to be altered sediments, or tuffs. Fossil remains have even been detected in some. They are close relatives of hälleflintas. (Kemp) It simulates a porphyritic volcanic rock (La Forge)

Porphyry. 1. Any igneous rock in which relatively large conspicuous crystals (phenocrysts) are set in a finer-grained or glassy groundmass. Porphyries are generally named in accordance with their rock composition (*e. g.*, granite porphyry, trachyte porphyry) or with the character of the phenocrysts, as quartz porphyry. 2. Colloquially, the word "porphyry" is used to mean almost any igneous rock, occurring in sheets or dikes, particularly one that is spotted, soft, or light colored. (U. S. Geol. Surv.)

Porphyry ware. A variety of Wedgwood ware. *See also* Pebble ware.

Porporino (It.). A glaze of mercury, tin, and sulphur, imitating gold; used by Italian and other artists of the middle ages for decorative purposes. (Standard)

Portabandera (Sp.). In surveying, a flag bearer. (Halse)

Portable electric lamps. Electric lamps that, while lighted, may be carried about. This general term includes lamps operated by batteries and lamps connected to a source of power by a flexible conductor whose length limits the range over which the lamp may be used. (H. H. Clark)

Portable motors. Motors that are intended for service here and there as occasion requires and that are so constructed or mounted as to facilitate moving them from place to place. (H. H. Clark)

Portabandera (Sp.). In surveying, a chainman. (Halse)

Portage (Fr.). Applied by *voyageurs* to the space or watershed that lies between the navigable branches of rivers belonging to the same or different hydrographic basins, and so called from the circumstance that boats and goods have to be carried from the one branch to the other. (Page)

Portal. 1. The surface entrance to a drift, tunnel, adit, or entry.
2. The concrete or masonry arch, retaining wall, etc., erected at the opening of a drift, tunnel, or adit.

Portaviento(Sp.). A blast pipe for conveying air to a furnace. (Halse)

Porter. A long iron bar attached to a forging, or a piece in process of forging, by which to swing and turn it. (Standard)

Portland beds. *See* Portland limestone.

Portland cement. A hydraulic cement consisting of compounds of silica, lime, and alumina (Webster). It is obtained by burning to semifusion an intimate mixture of pulverized materials containing lime, silica, and alumina in varying proportions within certain narrow limits, and by pulverizing finely the clinker that results.

Portland limestone; Portland beds. A series of limestone strata, belonging to the upper part of the Oölite group, found chiefly in England, in the island of Portland, on the coast of Dorsetshire. The great supply of the building stone used in London is from these quarries. (Comstock)

Portland stone. 1. A yellowish white oölitic building limestone from the Isle of Portland, England. 2. A purplish-brown sandstone from Portland, Conn. 3. Concrete made with Portland cement, sand, and gravel. (Webster)

Porto marble. A siliceous limestone of a black color, traversed by gold-colored veins; called also black and gold marble. The source is Porto Venere and the Isle of Palmeria in the Gulf of Spezia. (Merrill)

Portrait stone. A flat diamond, sometimes with several rows of facets around its edge, for covering very small portraits. (Standard)

Posepnyte. An oxygenated hydrocarbon from the Great Western mercury mine, Lake County, Cal. It occurs in plates and nodules, sometimes brittle, occasionally hard; the color is light green to reddish-brown; and the specific gravity ranges from 0.85 to 0.985. (Bacon)

Position blocks. Mining claims that are in a position to contain a lode if it continues in the direction in which it has been proved in other claims, but which themselves have not been proved. (Duryee)

Positive crystal. A crystal in which the refractive index of the extraordinary ray is greater than the refractive index of the ordinary ray. (Dana)

Positive ore. Ore exposed on four sides in blocks of a size variously prescribed. *See* Ore developed, *also* Proved ore. (H. C. Hoover, p. 17) Ore which is exposed and properly sampled on four sides, in blocks of reasonable size, having in view the nature of the deposit as regards uniformity of value per ton and of the third dimension, or thickness. (Min. and Met. Soc. of Am., Bull. 64, p. 262)

Possession (Derb.). When a windlass or frame, is placed on a vein it is said to be in possession. (Min. Jour.)

Possessio pedis. The actual possession of a mining claim by the first arrival. (U. S. Min. Stat., pp. 117, 118)

Possessory title. Title vested in the locator of a mining claim by compliance with the State and Federal mining laws. (Duryee)

Possible ore. Ore which may exist below the lowest workings, or beyond the range of actual vision. (Min. and Met. Soc. of Am., Bull. 64, p. 262)

Post. 1. A mine timber. Commonly used in the metal mines instead of *leg*, which is the coal miner's term. 2. The support fastened between the roof and floor of a coal seam used with certain types of mining machines or augers. (Steel)
3. A pillar of coal or ore. (Raymond)
4. (Eng.). Limestone strata divided horizontally with very thin beds of slate. (Hunt)
5. (No. of Eng.). A fine-grained sandstone. (Gresley)
6. A charge of ore for a smelting furnace. 7. Any of the distance pieces to keep apart the frames or sets in a shaft; a studdle. (Webster)
8. To bring the survey and maps of a mine up to date.

Post-and-stall. A mode of working coal, in which a certain amount of coal is left as pillar and the remainder is taken away, forming rooms or other openings. The method is called also Bord-and-pillar, Pillar-and-breast, etc.

Post brake. A hand- or power-actuated brake of a hoisting engine, consisting of one or more posts fixed at one end, the free end being operated so as to bring the post into frictional contact with the surface of the hoisting drum.

Post drill. An auger (or drill) supported by a post. (Steel)

Poste (Sp.). Post; stull; stake; pillar. *Postes*, masonry pillars against which the legs of a headframe abut. (Halse)

Post furnace. *See* Pernot furnace.

Post glacial. Subsequent to a period of glaciation; subsequent to the Pleistocene, or glacial, period. (Webster)

Posting (York). Extracting the post or pillars (Gresley). Pillar robbing.

Posting hole (York). *See* Bolt, 8.

Post jack. A jack for pulling posts (Standard). *See* Post puller.

Post puller. A lever-and-chain device for safely removing and recovering posts from worked-out portions of a mine.

Post puncher. A coal-mining machine of the puncher type supported by a post. (Steel)

Poststone. A fine-grained sandstone. (Power)

Pot. 1. A rounded mass of roof slate resembling an iron pot and easily detached. It is separated from the other slate by old mud cracks (Steel). Smaller than a bell-mold, or kettle bottom.
2. A metallic or earthen vessel of any of many rounded forms. 3. In ceramics, to make or shape and fire, as a piece of earthenware. (Webster)
4. A crucible, usually of fire clay, often of graphite. 5. The mass of consolidated material often filling a pothole. *See* Pothole, 1. (Standard)

Potable. Drinkable (Webster). Said of water and beverages.

Potash. 1. The oxide of potassium, K_2O. Not an independent compound, but used as a basis of comparison for all potash minerals and artificial salts. The potash of commerce is derived from the minerals carnallite, kainite, sylvite (not found in the United States), and niter, and also from certain sea-weeds and wood ashes. *See also* Alunite; Alunogen; Kalinite; Niter. (U. S. Geol. Surv.)

Potash alum. *See* Kalinite.

Potash feldspar. *See* Orthoclase.

Potash mica. *See* Muscovite.

Potassic. Of, pertaining to, or containing potassium. (Standard)

Potassium. A soft, light, silver-white metal of the alkali group, occurring abundantly in nature, but always combined. Symbol, K; atomic weight, 39.10; specific gravity, 0.865. (Webster)

Potato stone. A potato-like geode of quartz, having a central cavity lined with crystals. (Power)

Pot bottom. A large bowlder in the roof slate, having the appearance of the rounded bottom of a pot, and which easily becomes detached (C. and M. M. P.). *See* Pot, 1; *also*, Bell-mold.

Pot clay. A highly refractory fire clay used in the manufacture of pottery. (Standard)

Pot earth. Potter's earth. (Webster)

Potencia (Sp.). 1. Power; *P. calorífica*, calorific power. 2. The width or thickness of a vein. (Halse)

Potential. The words "potential" and "voltage" are synonymous and mean electrical pressure. The potential or voltage of a circuit, machine, or any piece of electrical apparatus means the potential normally existing between the conductors of such circuit or the terminals of such machine or apparatus. In Bureau of Mines practice: (a) Any potential less than 301 volts shall be deemed a low potential. (b) Any potential greater than 301 volts but less than 651 volts shall be deemed a medium potential. (c) Any potential in excess of 651 volts shall be deemed a high potential. (H. H. Clark)

Potelot. An old chemical and mineralogical term for molybdenum sulphide. (Standard)

Pot growan (Corn.). Soft decomposed granite. (Whitney)

Pothole. 1. A kettle or circular hole generally deeper than wide, worn into the solid rock at falls and strong rapids by sand, gravel, and stones being spun around by the force of the current (Roy. Com.). Called also Kettle hole, Swallow hole.
2. A hole in the ground from which clay for pottery has been taken. (Webster)
3. A hole extending below the wearing course in a roadway. (Bacon)
4. (Lanc.). A small temporary ledge in a sinking-pit. (Gresley)
5. A rounded cavity in the roof of a mine caused by a fall of rock, coal, ore, etc.

Potin (Fr.) A coin alloy of the ancient Gauls, consisting of copper, zinc, lead, and tin. (Standard)

Pot kiln. A small lime kiln. (Webster)

Pot lead. Graphite or black lead. (Century)

Potlid. A concretion found in sandstone or shale of the Jurassic. (Standard)

Pot metal. 1. Cast iron suitable for making pots. 2. A copper-and-lead alloy formerly used for large pots and for faucets, etc. 3. Glass colored throughout while fused; pot-metal glass. (Standard)

Pot mizer (Eng.). A boring tool occasionally used in clays mixed with pebbles. It is made in the form of a spiral cone, that is open at the top to receive the pebbles carried up by the worm. (Gresley). Also spelled Pot miser.

Potomac formation; Potomac series. The lowest division of the Cretaceous period in the Atlantic and Gulf area of the United States. (Standard)

Potsdam formation. A member of the Upper Cambrian of the United States and Canada, especially the original typical strata on the north and east sides of the Adirondak mountains, New York (Standard)

Pot-setting. In glass-making, the placing of a pot in a furnace for the purpose of melting metal. (Standard)

Potstone. A coarse or impure variety of soapstone; so called from being easy to cut into pots owing to its softness. (Roy. Com.)

Potter. 1. One whose occupation is to make earthen vessels. 2. A maker of metal pots. (Webster)

Potter-Delprat process. The original Potter process (1902) was one of flotation in a 1 to 10 per cent acid solution. The mixture was 1:1 of ore and acid solution; this was agitated freely and heat applied, with the generation of CO_2 from the carbonates in the ore. This caused the sulphides to rise to the surface where they were either allowed to flow off continuously or were skimmed off. This was clearly a surface tension process. Delprat (1902) accomplished the same thing with acid salt-cake solution. Both processes were tried out at Broken Hill, Australia. Later patents indicate that oil has been found to assist in this process. These inventors worked independently, became involved in litigation and eventually pooled their interests. (Liddell)

Pottern ore. A term used in early metallurgical practice for an ore that becomes vetrified by heat, like the glazing of earthenware. (Standard)

Potters' clay; Pipe clay. Pure plastic clay, free from iron, and consequently white after burning. (U. S. Geol. Surv.)

Potters' consumption. An acute bronchitis often occurring among persons employed in potteries, eventually affecting the lungs. Called also Potters' asthma, and Potters' bronchitis. (Standard)

Potters' lead. *See* Alquifou.

Potters' ore. *See* Alquifou.

Potters' wheel. A horizontal disk, revolving on a vertical spindle, and carrying the clay in the operation of throwing, which *see*. (Webster)

Pottery. 1. A shop or factory where earthen vessels are made. 2. The art of the potter; ceramics. 3. Ware made from certain earthy materials. Usually clay, molded while moist and soft and hardened by heat (Webster). The principal varieties are: (1) *Earthenware*, characterized by comparative softness and fusibility in a porcelain furnace. It includes: (a) *Unglazed ware;* (b) *Lustrous ware;* (c) *Glazed ware;* and (d) *Enameled ware.* (2) *Stoneware*, characterized by hardness and infusibility owing to the silica in the clay forming the body. *See* Porcelain.

Pottery kiln. A kiln for firing pottery. (Standard)

Pottery tree. Any one of various South American trees of the rose family, the hard and brittle bark of which contains a great quantity of silex, that the Indians obtain by burning and mingle with clay to form pottery. (Standard)

Potting. The placing of pots, containing either potassium nitrate or sodium nitrate and sulphuric acid, in the kilns used in the manufacture of sulphuric acid from sulphurous acid obtained from the combustion of sulphur in air. (Century)

Pottsville conglomerate. A conglomerate formation at the base of the Pennsylvanian in the Northern Appalachian region; millstone grit. (Webster)

Potty. Containing pots. *See* Pot, 1. Also applied to any roof in a coal mine which falls down in thick blocks. (Steel)

Potwork. 1. (Prov.) Pottery or pottery ware 2. (Eng.) A place where common pottery is made. (Standard)

Pound. 1. A unit of weight varying from 300 to about 1,070 grams, and commonly divided into 12 or 16 ounces. Among English-speaking peoples, the avoirdupois pound of 7,000 grains is the standard of weight for most purposes; but the troy pound of 5,760 grains is the standard for gold and silver and a few other costly articles. (Webster)
2. An underground reservoir of water. *See* Lodge, 1. 3. A large natural fissure or cavity in the strata. (Gresley)
4. The gold monetary unit of Great Britain equal to $4.8665.

Poundage. 1. (Scot.) Interest sometimes paid for money advanced before pay day. (Barrowman)
2. In salt making, the number of pounds of salt in a gallon or cubic foot of brine. (Webster)

Pounder. An ore-mill stamp. (Standard)

Poundstone. 1. (Shrop.) The stone or clay floor under the coal. (Gresley)
2. A stone, pebble, or large echinite, weighing a pound, used as a weight. (Webster)

Pounson (No. Wales). Dense soft clay underlying coal beds. (Gresley)

Pour. A term used in founding. 1. The amount of material, as melted metal, poured at a time. 2. The act, process, or operation of pouring melted metal; as, make a *pour* at noon. (Standard)

Pourie (Scot.) (pronounced poorie). A small oil can with a spout from which oil is poured to lubricate machinery. (Barrowman)

Pouring-gate. A channel in a mold, through which to pour molten metal. (Standard)

Pout (No. of Eng.). A tool for knocking out or drawing timbers in the mine workings. (Gresley)

Powder. 1. Any of various solid explosives, as gunpowder used in gunnery, blasting, etc. 2. The fine particles to which any dry substance is reduced by pounding, grinding, etc.

Powder barrel. A barrel made for the conveyance of gunpowder, usually containing 100 pounds (Standard). *Compare* Powder keg.

Powder house. A magazine for the temporary storage of explosives.

Powder jack. *See* Jack, 3.

Powder keg. A small metal keg for black blasting-powder, usually having a capacity sufficient for 25 pounds of powder.

Powder man. A man in charge of explosives in an operation of any nature requiring their use. A powder monkey.

Powder monkey. 1. A person employed at the powder house of a coal mine whose duty it is to deliver powder to the miners. (Folsom-Morris Coal Mining Co. *v.* DeVork, 160 Oklahoma, p. 65.)
2. In some metal mines, the person who distributes powder, dynamite and fuse to the miners at the working faces. This is a nautical term, but is frequently used in the mining industry.

Powdered ore (Aust.). Ore disseminated with vein stuff. (Power)

Powder mine. An excavation filled with powder for the purpose of blasting rocks. (Century)

Powellite. A mineral composed of calcium molybdate and calcium tungstate. $Ca,(Mo,W)O_4$. Occurs in minute yellow tetragmal pyramids. (Dana)

Powellizing process. A wood treatment consisting of impregnating the wood with a saccharin solution. It hardens the wood, and renders it fireproof to some extent. (Liddell)

Power. Any form of energy available for doing any kind of work; as steam-*power;* water-*power;* specifically, mechanical energy, as distinguished from work done by hand (Standard). Often used to indicate the electric current in a wire; as, to turn on the *power.*

Power distillate. The untreated kerosene condensates and still heavier distillates down to 28° Bé. from Mid-Continent petroleum, used as fuel in internal combustion engines. (Bacon)

Power drill. A rock drill employing steam, air, or electricity as a motive agent. (Ihlseng)

Power factor. The ratio of the electric power in watts to the apparent power in volt-amperes, in an alternating-current circuit or apparatus. (Webster)

Power gas. Any gas made for producing power, as for driving gas engines. (Webster)

Power house. The building in which the prime motor of a system of works is installed, and from which power is transmitted to the other parts of the system. (Standard)

Pox stone. A hard stone of a gray color found in some Staffordshire mines. (Century)

Pozo (Sp.). A pit, shaft, or winze; *P. de arrastre*, an inclined shaft or winze; *P. de bombas*, a pumping or drainage shaft; *P. de escalas*, a ladder-way shaft; *P. de extracción*, a hoisting shaft; *P. de ventilación*, an air shaft; *P. maestro*, the main shaft. (Halse)

Pozzuolana. A leucitic tuff quarried near Pozzuoli, in Italy, and used in the manufacture of hydraulic cement. (La Forge) Artificial pozzuolana is made from slag, ash, etc. (Webster) Also spelled Pozzolana and Pozzuolane.

Practical shot. In coal mining, a shot for which the hole has been drilled in a direction selected with reasonable care, and that has been filled with powder and tamped with the same degree of care. (Bolen-Darnell Coal Co. *v.* Hicks, 190 Fed. Rept., p. 719)

Prase. A translucent and dull leek-green variety of chalcedonic quartz. (Dana)

Praseodymium. A rare metallic element. Symbol, Pr; atomic weight, 140.90; specific gravity, 6.475. (Webster)

Praseolite. A green alteration product of iolite. (Dana)

Prasoid. Resembling prase. (Standard)

Prata (Port.). Silver; *P. en barras*, silver in bars. (Halse)

Pre-Cambrian. Older than, or occurring before, the beginning of the Cambrian; especially, all that part of geologic time represented by rocks older than Cambrian; also, such pre-Cambrian rocks, collectively. (La Forge)

Precious. A term used by mineralogists to imply the finest variety of gems or minerals; *e. g.*, precious garnet, precious beryl, etc. (Power)

Precious garnet. A synonym for Pyrope.

Precious metals. The uncommon and highly valuable metals, especially gold and silver (Webster). Also platinum and associated metals.

Precious opal. Opal exhibiting a play of delicate colors. (Dana)

Precipice. A very steep, perpendicular or overhanging place, as the face of a cliff; an abrupt declivity. (Webster)

Precipitador (Mex.). A workman in a leaching mill who adds the precipitant to the silver solutions. (Dwight)

Precipitadora (Sp.). A precipitating vat or tank. (Halse)

Precipitant. Any agent, as a reagent, that when added or applied to a solution causes a precipitate of one or more of its constituents. (Standard)

Precipitate. A substance (held in solution in a liquid) thrown down in a solid form by the addition of some other substance in solution. When a substance held only mechanically in suspension in a liquid settles to the bottom it is called a sediment. (Roy. Com.)

Precipitation process. The treatment of lead ores by direct fusion with metallic iron or slag or ore rich in iron; performed generally in a shaft-furnace, rarely in a reverberatory. Often combined with the roasting and reduction process. (Raymond)

Predazzite. A contact rock at Predazzo, in the Tyrol, produced by an intrusion of syenite in crystalline dolomite. It is partly calcite and *partly* brucite or hydromagnesite. Pencatite is the same aggregate, darkened by grains of pyrrhotite. (Kemp)

Preemption Act. An Act providing for a patent to agricultural lands. The Act does not include mineral deposits, as they are expressly reserved. (Gold Hill Quartz Mining Co. *v.* Ish, 5 Oregon, p. 108)

Preferential flotation. A name applied to a special type of differential flotation in which a mixture of two flotative sulphide minerals is given a slight roast in order that one may be oxidized, and therefore not float, and the other remain unchanged. (O. C. Ralston)

Preglacial. Of, pertaining to, or occurring in geologic time before the glacial epoch. (Standard)

Preglacial drift. Loose sand and gravel lying beneath the till in Iceland. (Century)

Preheat. To heat previously, as a charge to be subsequently treated in an electric furnace, or compressed air before it is allowed to expand in a compressed-air engine. (Webster)

Prehnite. A hydrous silicate of calcium and aluminum, $H_2Ca_2Al_2(SiO_4)_3$. (Dana)

Premeridian. In the terminology of Rogers, denoting the rocks of the Lower Helderberg period immediately underlying the Meridian series; characterizing the seventh of the fifteen series of the Paleozoic strata of the Appalachian region. (Standard) Usage is obsolete.

Premium. 1. The consideration paid, whether in money or otherwise, for a contract of insurance. 2. The excess in purchasing power, or exchange value, of one form of money over another of the same nominal value, as of gold dollars over paper ones, or of silver dollars over paper ones; above par. (Webster)

Prensa (Mex.). A vise; a press. (Dwight)

Preparación (Sp.). 1. Opening out or development as distinguished from exploitation. 2. *P. mecánica*, ore dressing. (Halse)

Preparar (Sp.). To prepare; *P. minerales*, to dress ores. (Halse)

Preparation. The treatment of ore or coal to reject waste. *See* Concentration; *also* Ore dressing.

Prepare. 1. To shear or undermine the coal so that it can be readily blasted loose. 2. (Ark.) To make a cartridge for a blast. 3. (Ark.) To charge a blast hole. (Steel)

Prerelease. The act of discharging steam or air from an engine cylinder before the piston has reached the end of its stroke. (Ihlseng)

Presa (Sp.). A dam. (Min. Jour.)

Present worth. That principal which, drawing interest at a given rate, will amount to the given sum at the date on which this is to be paid (Webster). The value *now* of a sum due at some future date, with or without interest. (E. B. Skinner, p. 68)

Press cake. The incorporated gunpowder or mill cake, pressed and ready for granulation. (Century)

Pressed distillate. The oil coming from the presses when paraffin wax is recovered. (Bacon)

Pressed fuel. An artificial fuel prepared from coal dust, waste coal, etc., incorporated with other ingredients, as tar, and compressed in molds into blocks (Century). Briquets.

Presser. In ceramics, the workman who molds the handle, ears, and decorative reliefs to be applied to a pottery vessel before firing. (Century)

Pressure anemometer. An anemometer showing the wind's velocity by means of the pressure exerted (Standard), as for measuring the velocity of ventilating air currents in mines.

Pressure blower. A machine or blower having either pistons, cams, or fans for furnishing an air-blast above atmospheric pressure. (Standard)

Pressure box. A cistern at a considerable elevation, fed by a flume, ditch or pipe, to supply water under a head. (Webster)

Pressure fan. 1. A fan supplying air under pressure (Webster). 2. A fan that forces fresh air into a mine as distinguished from one that exhausts air from the mine.

Pressure figure. A figure produced by intersecting lines of parting, due to gliding when certain minerals, like mica, are compressed by a blunt point. They are similar in character, but not in position, to the so-called *percussion-figures* produced by a sharp point. (Standard)

Pressure filter. A filter in which the liquid to be filtered is forced through filtering material by a pressure greater than its own weight in the filter. (Century)

Pressure-forging. Forging done by a steady pressure, as in a hydraulic press. (Standard)

Pressure wires. Wires leading from various points of an electric system to a central station, where a voltmeter indicates the potential of the system at those points. (Webster)

Prian (Corn.). Soft white clay. (Raymond)

Priceite. A friable, chalky boron mineral similar to colemanite. *See also* Colemanite. (U. S. Geol. Surv.)

Pricked. In ceramics, ornamented with dotted depressions made with a single point or with a comb. (Standard)

Pricker. 1. (Eng.) A thin brass rod for making a hole in the stemming, when blasting, for the insertion of a fuse. 2. (So. Staff.) A long iron rod or poker used for loosening coal from overhead. 3. A piece of bent wire by which the size of the flame of a safety lamp is regulated, without removing the top of the lamp. It passes up into the lamp through the oil reservoir in a tube. (Gresley)
4. An iron rod for probing or sounding a bog, quicksand, etc. (Webster)

Pricking. 1. The act of lifting or loosening with a lever or a pick. (Gresley)
2. (Scot.) A thin stratum suitable for holing. (Barrowman)

Pricking bar. 1. A bar used in opening the tap hole of a furnace. 2. A rod used for removing obstructions from tuyères and blow pipes. (Willcox)

Pride of the country (Corn.). Rich bodies of ore near the surface. (Davies)

Prill. 1. (Corn.) The best ore after cobbing. 2. *See* Button. (Raymond)
3. (Eng.) A nugget of virgin metal. (Webster)

Prillion. Tin extracted from slag. Also spelled Prillon. (Standard)

Prima oil. The trade name for a shale oil with a low density and low boiling point. (Bacon)

Primary. 1. Characteristic of or existing in a rock at the time of its formation: said of minerals, textures, etc., of rocks; essentially the same as Original 1, and contrasted with Derived, or Secondary, 1. 2. Formed directly by solidification from fusion or deposition from solution: said of igneous rocks and chemical sediments and contrasted with Derivative (little used). 3. Originally the same as the present pre-Cambrian, then extended to include the present Paleozoic, and later restricted to Paleozoic; finally abandoned and now obsolete. (La Forge)

Primary blasting. A term applied to the blasts by means of which the original rock ledge is broken into fragments. (Bowles)

Primary clay. Clay that is found in its place of formation (Webster). Residual clay.

Primary coil. The coil through which the primary current passes in an induction coil or transformer. (Webster)

Primary drilling. The process of drilling holes in a solid rock-ledge in preparation for a blast by means of which the rock is thrown down. (Bowles)

Primary minerals. Those minerals that retain their original form and composition, as original sulphides. *Compare* Secondary minerals. *See* Primary, 1.

Prime. 1. To pour water into to displace air and thus promote suction; as, to *prime* a pump (Standard). 2. To insert a detonator into a cartridge of explosive and attach it thereto. (Du Pont)

Prime city naphtha. A petroleum product with a gravity of from 73° to 68° Bé. *See* Benzoline, 1. (Bacon)

Prime mover. An engine, or machine, the object of which is to receive and modify force and motion as supplied by some natural source, and apply them to drive other machinery, as a water wheel, a windmill, turbine, steam engine, etc. (Webster)

Primer. A dynamite cartridge, or package of any explosive, which contains the detonator, whether blasting-cap or electric blasting-cap. (Du Pont)

Prime white oil. A kerosene of prime white color, that is intermediate in color between water-white and standard-white. *See* Standard-white oil. (Bacon)

Priming horn. A miner's or quarryman's powder horn. (Century)

Priming powder. Detonating or fulminating powder. (Standard)

Priming tube. A tube containing fulminating powder for firing a charge (Standard). A detonator.

Priming valve. 1. A safety valve on the working cylinder of a steam engine to discharge the priming. (Standard)
2. A valve connected with the discharge pipe of a force pump through which the pump may be primed.

Primitive. Same as Primary 3, *which see:* obsolete. (La Forge)

Primitive circle. In crystallography, the great circle in the plane of projection (stereographic projection). (A. F. Rogers)

Primitive form. A crystal form from which other forms may be derived. (A. F. Rogers)

Primitive rocks. Rocks supposed to be first formed, and containing no organic remains, being irregularly crystallized and aggregated without a cement, such as granite, gneiss, and the like (Thompson). *See* Primary

Primordial. In geology, formerly used for what is now called Cambrian, *which see:* Obsolete. (La Forge) The name was given by Barrande to the oldest fossiliferous rocks as developed in Bohemia. It corresponds with the British Cambrian. (Roy. Com.)

Primordial zone. The lowest geological formation known to contain a fossil fauna; equivalent to the Cambrian. (Standard) Usage now obsolete.

Principal. 1. (Colom.) Artificial channel or drain used in alluvial mining. 2. (Sp.) Shaft of a water wheel. (Halse)

Principal axis. In the tetragonal and hexagonal systems, the vertical crystallographic axis; hence, what is the same thing, in uniaxial crystals, the optic axis. (La Forge)

Principal meridian. A meridian line accurately located and used as a basis from which to construct interior lines of monuments, called guide meridians, for the use of surveyors. (Standard)

Principal section. In crystallography, the plane passing through the optical axis of a crystal. (Standard)

Pringap. The distance between two mining possessions in Derbyshire (Raymond). An odd piece of mining ground of less than half a mere. (Mander)

Print. 1. A projection on a core, by which it is placed and held in proper position in a mold; a core point. 2. An impression of a pattern or of a part thereof, as in molding sand. (Standard)

Printed ware. Pottery decorated by transfer-printing. (Standard)

Printing body. Pottery when in condition to be printed; biscuit. (Standard)

Prism. 1. In crystallography, in the tetragonal and hexagonal systems, an open form of similar faces parallel to the vertical axis. 2. In the orthorhombic, monoclinic, and triclinic systems, an open form of similar faces parallel to the vertical axis and intersecting both lateral axes. (La Forge) 3. A solid whose bases or ends are similar, equal, and parallel polygons, the faces being parallelograms. (Standard)

Prism level. A kind of dumpy level with a mirror over the level tube, and a pair of prisms so placed that the position of the level bubble can be determined at any time by the levelman without the necessity of moving his head from the eyepiece. (Webster)

Prize (Leic.). To lift or loosen with a lever or a pick. (Gresley)

Probable ore. Any blocked ore not certain enough to be "in sight" and all ore that is exposed for sampling, but of which the limits and continuity have not been proved by blocking. Also, it includes any undiscovered ore of which there is a strong probability of existence. Ore that is exposed on either two or three sides. Whether two or three sides be taken as a basis will depend on the character of the deposit. (Min. and Met. Soc. of Am., Bull. 64, pp. 258 and 262)

Probing (Derb.). Boring or drilling for testing mineral ground. (Mander)

Procellas. In glass-making, a pair of spring-tongs with flat jaws, used to reduce the external diameter of a glass object as it is rotated by the pontil. Also spelled Pucellas. (Sandard)

Processioner (Local U. S.) An official land-surveyor. (Standard)

Processioning (Prov. U. S.) The official inspection of boundaries and maintenance of surveyors' marks, as in North Carolina and Tennessee and possibly in some of the British colonies. (Standard)

Prochlorite. One of the chlorite group. Lower in silicon than clinochlore, and with ferrous iron usually, but not always, in large amount. (Dana)

Produce. 1. The marketable ores or minerals produced by mining and dressing. 2. (Corn.) The amount of fine copper in one hundred parts of ore. (Raymond)

Producer. 1. One who grows agricultural products, or manufactures crude materials into articles of use (Webster). Also one who extracts, ore or coal from mines; rock from quarries; metals from ore by metallurgical processes, etc. *See* Production.
2. *See* Gas producer.

Producer gas. A combustible gas to be used for fuel, for driving gas engines, for making illuminating gas, etc., made by forcing steam and air through a layer of incandescent fuel, as coke, the resulting gas consisting largely of carbon monoxide and nitrogen. (Webster)

Production. That which is produced or made; any tangible result of industrial or other labor (Standard). The yield or output of a mine, metallurgical plant, or quarry.

Productive. Yielding payable ore. (Duryee)

Producto (Sp.). Product, return, or yield. (Halse)

Profile. 1. An outline or contour; a drawing in outline, as in vertical section or the like. Specifically, the outline of a vertical section through a country or line of work, showing actual or projected elevations and hollows, generally with the vertical scale much greater than the horizontal. 2. In ceramics, a metal plate giving in hollow section the exterior outline of half of the object to be made, so that when placed against the clay on the rotating throwing wheel it will shape it to the desired form. (Standard)

Profile paper. Paper ruled horizontally and vertically with equidistant lines to scale, for convenience in drawing engineering profiles in either direction. (Standard)

Profit in sight. Probable gross profit from a mine's ore reserves, as distinct from the ground still to be blocked out. (Skinner)

Profundidad (Sp.). Depth, as of a shaft or winze. (Halse)

Profundización (Sp.). Sinking or deepening. (Halse)

Progressive powder. A gunpowder made so that it burns slowly at first, and then with increasing rapidity, to avoid the extreme pressure caused by the explosion of powders in which the combustion is instantaneous. (Webster) A slow-burning explosive. *Compare* Propellant explosives.

Projection. 1. In alchemy, the casting of a substance, especially philosopher's stone, into a molten metal with the supposed result of transmuting the latter. (Standard)
2. The act or result of constructing a figure upon a plane or other sur-

face which corresponds point for point with a sphère, spheroid or other figure. (Century)

Prolong. Generally a simple cone or canister of sheet iron for condensing zinc. The chief requisites are the provisions of ample cooling surface, the insurance that the gas will come in contact therewith in order to assist in the condensation of zinc which may be carried off by the escaping stream of gas. Prolongs are of two types, vertical and horizontal. (Ingalls, p. 554)

Promising. Looking as if likely to turn out well; as in mining, a *promising* prospect.

Promontorio. 1. (Sp.). A considerable elevation of ground; a promontory or headland. 2. (Mex.). An irregular deposit or mass. (Halse)

Promoter. A person who alone or with others sets on foot, and takes the preliminary steps in, a scheme or undertaking for the organization of a company, the floating of bonds, stocks, etc., or the carrying out of any business project (Webster); *e. g.*, a mine *promoter*.

Prong (Eng.). The forked end of the bucket-pump rods for attachment to the traveling valve and seat. (C. and M. M. P.)

Prony's dynamometer. A dynamometer for obtaining data for computing power delivered by turbines and other waterwheels, or from the fly wheel of an engine, or transmitted by shafting. (Century)

Prop. A timber set upright or at right angles to the dip, to support the roof rock (Chance). A strut or post in tunnel construction work, either vertical or raking, usually of round timber, used as a support, or stay. A raking prop is sometimes called a raker.

Propagate. To transmit or spread from place to place; as coal-dust propagates a mine explosion.

Propagated blast. A blast consisting of a number of unprimed charges of explosives and only one hole primed, generally for the purpose of ditching, where each charge is detonated by the explosion of the adjacent one, the shock being transmitted through the wet soil. In this method, one detonator fired in the middle of a line of holes is capable of bringing about the explosion of several hundred such charges. (Du Pont)

Propellant explosives. Those explosives in which the velocities of combustion are regulated, either by chemical composition or by preparing the explosive in various shapes. (Brunswig, p. 286)

Prop-crib timbering. Shaft timbering with cribs kept at the proper distance apart by means of props. (Raymond)

Prophylene-glycol dinitrate explosive. A term used by Dr. Charles E. Munroe to define an explosive containing the liquid ingredients named, in contradistinction to *dynamite*, which contains nitroglycerin. In commerce the term *dynamite* is loosely used to include any mixture containing a liquid explosive.

Propiedad (Sp.). Property; *P. minera*, a mining property; *P. mueble*, personal property; *P. raiz*, real estate. (Halse)

Propietario (Sp.). Proprietor; *P. de una mina*, owner of a mine. (Halse)

Prop maul (Eng.). An iron maul, with a wooden handle, used by the deputies in drawing or setting props. (G. C. Greenwell)

Proposition. A project, undertaking, affair, or the like, involving some action, as in carrying out, managing, operating, passing of judgment, with reference to it; as in mining, an alluvial *proposition*. (Webster)

Propping. The timbering of a mine. (Gresley)

Prop slicing. *See* Top slicing and cover caving.

Prop stay. A stay used to strengthen tubes and water spaces, in steam boilers, or large tubes and annular spaces, in air tanks, and resist pressure tending to collapse or rupture (Century). The opposite of tie-rod, which resists tension.

Propulsive. A term applied to the kind of force exerted by an explosive that tends to push out masses of rock rather than to break them up. (Bowles) *See also* Progressive powder.

Prop wood. (Eng.). Timber suitable for cutting, or already cut into props. *See* Prop. (Gresley)

Propylite. A name given by von Richthofen in 1867 to certain andesites, formed at the beginning of Tertiary time, that were thought to resemble the old diorites and diorite-porphyrites. They had been previously

called by him greenstone-trachytes in Hungary, but were not named propylite until he found them in Nevada and California. The western propylites have been since conclusively shown by several American petrographers to be only more or less altered andesites. The literature of the name furnishes an interesting and amusing exhibition of the efforts of those petrographers, who were influenced by the time-myth in the classification of igneous rocks, to draw distinctions, where there were no differences. The name means 'before the gates,' alluding to their position at the beginning or entrance to the Tertiary, which was supposed to usher in the true, volcanic eruptions of geological time. (Kemp) Now obsolete.

Propylitic. A term that may be applied to any kind of a vein, meaning that the ore solution which has furnished the vein filling has also effected a decomposition or alteration of the wall rock as well, so that the walls of the vein consist of clay, talc, etc. (Shamel, p. 155)

Prórroga (Mex.). An extension of time. (Dwight)

Prospect. 1. The name given to any mine workings the value of which has not yet been made manifest. A prospect is to a mine what mineral is to ore (Ihlseng). A mineral deposit, or excavation more or less superficial, indicating a deposit. (Webster)
2. To examine land for the possible occurrence of coal or valuable minerals by drilling holes, ditching, or other work. (Steel)
3. The gold or other mineral got by working a sample of ore.

Prospectar; Explorar; Catear (Sp.) To prospect. (Halse)

Prospect hole. Any shaft, pit, drift, or drill hole made for the purpose of prospecting the mineral-bearing ground.

Prospecting. Searching for new deposits; *also*, preliminary explorations to test the value of lodes or placers already known to exist.

Prospecting claim (Aust.). A larger mining claim than is usually granted, and given to the first prospector who discovers gold in a district. (Webster)

Prospective ore. Ore that can not be included as proved or probable, nor definitely known or stated in terms of tonnage. *See* Possible ore, *also* Ore expectant. (H. C. Hoover, p. 19)

Prospector. A person engaged in exploring for valuable minerals, or in testing supposed discoveries of the same. (Roy. Com.)

Prospect tunnel, or entry. A tunnel or entry driven through barren measures, or a fault, to ascertain the character of strata beyond. (C. and M. M. P.)

Prospectus. A preliminary written or printed statement of a plan or scheme proposed affording a prospect of its nature, as of a business undertaking, the conditions of incorporation, and apparent future promise of a company, issued by its promotors (Webster). Common in mining.

Protaxis. In geology, the oldest of the mountain ranges in a mountain chain (Standard). (Now obsolete).

Protean stone. An alabaster-like artificial stone made from gypsum. (Standard)

Protector lamp (Eng.). A safety lamp the flame of which it is impossible to expose to the outside atmosphere, as unlocking, or rather unscrewing it, extinguishes the light. (Gresley)

Proteolite. An old name for certain contact rocks produced by granite intrusions from slates. *Compare* Cornubianite. (Kemp)

Proterobase. Originally applied by Gümbel, 1874, to Silurian or earlier diabases with hornblende. The frequency of the paramorphism of augite to hornblende has led others to apply it to diabases with uralitized augite. Rosenbusch restricts i to diabases with original hornblende. (Kemp)

Proterozoic. In the usage of some geologists, the era that comprises the Algonkian period (La Forge). The era that elapsed between the close of the formation of the igneous complex and the beginning of the lowest system, which is now known to contain abundant well-preserved fossils. The time between the close of the Archeozoic and the Paleozoic and including the Huronian, Animikean, and Keweenawan periods. (Chamberlin)

Protoclase. A rock possessing cleavage originally developed during sedimentation under water or cooling from magma, such as bedding, flow structure, etc. *Compare* Metaclase. (U. S. Geol. Surv., Bull. 239, p. 12)

Protoclastic structure. 1. An original magmatic flow structure. (Leith, p. 87). 2. Having a structure derived from the solidification of molten rock, in which the crystals are more or less fractured or brecciated by the operation of forces during a late stage of the original consolidation. (Standard)

Protocolo (Sp.). Minutes; protocol; registry; a judicial registry. (Halse)

Protogenic; Protogenetic. Of or pertaining to a first origin or production. Specifically: Of or pertaining to those crystalline rocks supposed to be formed by igneous action. (Standard)

Protogine. An old name for a granite or gneiss in the Alps, consisting of quartz, orthoclase, and chlorite or sericite, the last-named of which was formerly erroneously taken for talc. The laminated structure from dynamic metamorphism is often pronounced (Kemp). A chloritic or sericitic variety of granite gneiss: obsolescent. (La Forge)

Protore. Low-grade material which by natural processes of enrichment is convertible into ore; as, for example, the so-called primary ore of the disseminated copper deposits, containing generally less than .5 per cent of copper. (Ransome)

Protoxide. The oxide of any metal containing the least proportion of oxygen. (Weed)

Protractor. An instrument for laying down and measuring angles on paper: used in drawing and plotting. (Webster)

Proud coal (Scot.). Coal that naturally splits off in flakes or slabs when worked in a particular manner, producing waste, by deterioration. (Gresley)

Proustite. A light-ruby, silver-arsenic sulphide mineral, $2Ag_3S.As_2S_3$. Contains 65.4 per cent silver. (U. S. Geol. Surv.)

Prove. 1. (Eng.) To ascertain by boring, driving, etc., the position and character of a coal seam, a fault, etc. 2. (Scot.) To examine a mine in search of fire-damp, known as 'proving the pit.' (Gresley)

Proved ore. Ore where there is practically no risk of failure of continuity (H. C. Hoover, p. 19). *See also* Positive ore.

Prove up. To show that the requirements for receiving a patent for government land have been fulfilled. (Webster)

Providor (Braz.). A collector of tribute and other taxes. (Halse)

Proving hole. 1. A borehole drilled for prospecting purposes. 2. A small heading driven to find a bed or vein lost by a dislocation of the strata, or to prove the quality of the ore in advance of regular workings. (Chance)

Proximate analysis. The determination of the compounds contained in a mixture as distinguished from *ultimate analysis*, which is the determination of the elements contained in a compound (Standard). Used in the analysis of coal.

Prueba (Mex.). A test; *P. de crudo*, a test made when the *torta* is supposed to be *rendida*, or worked, to ascertain whether there is sufficient mercury present. (Dwight)

Prussic acid. Same as Hydrocyanic acid.

Pryan. 1. (Corn.) A fine, white, somewhat friable clay (Webster). Also Prian. 2. Ore in small pebbles mixed with clay. (U. S. Geol. Surv.)

Prypole. The pole which forms the prop of a hoisting gin, and stands facing the windlass. (Webster)

Psammite. Any sedimentary rock composed of detrital material of the size and general character of sand, as sandstone and arkose. (La Forge)

Psammitic. Made up of particles the size of sand. (Power)

Psephite. Any sedimentary rock composed of coarse detrital material, such as pebbles: said of such rocks as conglomerate. (La Forge) The name is derived from the Greek for pebble. (Kemp)

Psephitic. Made up of small stones. (Power)

Pseudamygdule. A mineral nodule that replaces a primary constituent of a crystalline eruptive rock, so as to appear like a true vesicular filling or amygdule. (Standard)

Pseudo. As a prefix, implies something false; but its meaning is modified by the subject to which it applies. (Emmons)

Pseudobrookite. A titanium-iron oxide resembling brookite, occurring in cavities of some volcanic rocks, as andesite. (Century)

Pseudochrysolite. A synonym for Moldauite; Bouteillenstein. (Kemp)

Pseudoconglomerate. A rock so broken up into displaced fragments and interpenetrated by intrusive material as to appear like a conglomerate.

Pseudocrystalline. Composed of detrital crystalline grains little worn and solidly compacted by siliceous or other mineral accretion, so as strongly to resemble true crystalline rock. (Standard)

Pseudodiabase. A name proposed by G. F. Becker for certain metamorphic rocks in the Coast ranges of California that are supposed to have been derived from sediments, yet that have the minerals and texture of diabase. *Compare* Metadiabase, which means the same thing and has precedence. (Kemp)

Pseudodiorite. Diortic rocks produced as described under pseudodiabase. (Kemp)

Pseudogalena. Sphalerite. (Standard)

Pseudoisotope. An element behaving as an isotope with respect to another element, as far as chemical precipitation is concerned, but not truly isotopic with it as evidenced by having a different atomic number, atomic weight, and being separable from it by fractional crystallization. (S. C. Lind)

Pseudoisotopy. Having the properties of a pseudoisotope.

Pseudomalachite. A hydrous phosphate of copper occurring ordinarily in massive forms of bright-green color, much resembling malachite.

Pseudomorph. A crystal, or apparent crystal, having the outward form proper to another species of mineral, which it has replaced by substitution or by chemical alteration. (La Forge)

Pseudomorphous quartz. Quartz under the forms of many of the mineral species, which it has taken through either the alteration or replacement of crystals of those species. The most common quartz pseudomorphs are those of calcite, barite, fluorite, and siderite. *Silicified wood* is quartz pseudomorph after wood.

Pseudoporphyritic. Having a porphyritic appearance or character, but no true phenocrysts. (Standard)

Pseudospherulite. A spherulite in which the rays are composed of two different determinable substances, usually quartz and feldspar.

Pseudostromatism. A rock structure approximately resembling false bedding produced by numerous minor thrust-fault planes. (Standard)

Pseudosymmetry. Apparent symmetry, of higher grade than that proper to the mineral, generally due to twinning (La Forge). Called also Mimetry.

Pseudovolcano. A false volcano; an eruptive vent not emitting lava like a true volcano. (Webster)

Ptilomelane. A manganese hydrate and a common ore of manganese. Perhaps H_4MnO_5. (U. S. Geol. Surv.)

Psychrometer. An instrument for determining the tension of aqueous vapor in the air or the relative humidity (Century). *See* Sling psychrometer.

Ptilolite. A zeolitic mineral occurring in white tufts or spongy masses of minute acicular crystals, formed in cavities of augite-andesite. (Century)

Public domain. All lands and waters in the possession and ownership of the United States, including lands owned by the several States, as distinguished from lands owned by individuals and corporations. (Kinney on Irrigation, sec. 124; Winters *v.* United States, 143 Fed. Rept., p. 748)

Public land. Land subject to sale or other disposition by the United States under general laws. Land once reserved by the Government or appropriated for any special purpose ceases to be a part of the public lands. (Winters *v.* United States, 143 Fed. Rept., p. 748; Kinney on Irrigation, sec. 124.)

Puchos (Bol.). Small heaps of roasted ore. (Halse)

Puck. A wall or pillar built of waste rock to support the roof. (Raymond)

Pudding stone. A conglomerate in which the pebbles are rounded. *Compare* Breccia. (Raymond)

Puddle. 1. To subject iron to the process of puddling so as to convert it from cast-iron into wrought iron. 2. Clay, or a mixture of clay and sand, kneaded or worked when wet, to render it impervious to water. Also called Puddling. 3. A small pool. (Webster)

Puddle-ball. The lump of pasty wrought-iron taken from the puddling furnace to be hammered or rolled. (Webster)

Puddle-bar. An iron bar made at a single heat from a puddle-ball by hammering and rolling. (Webster)

Puddler. 1. One who converts cast-iron into wrought-iron by puddling. 2. A rabble used in puddling. 3. A puddling furnace. 4. A system of small pipes admitting compressed air to a tank of water and zinc chloride to effect a thorough solution for use as a timber preservative. (Webser)

Puddle rolls. The roughing-rolls through which puddle-balls are passed to be converted into bars. Called also Puddle-train. (Standard)

Puddle-steel. Steel made by the puddling process.

Puddler's mine. A soft, compact hematite, sometimes used for the bottoms of puddling furnaces. (Webster)

Puddle train. A train of rolls for reducing squeezed puddle-balls to puddle or muck-bars. (Raymond)

Puddling. 1. The process of decarburizing cast-iron by fusion on the hearth of a reverberatory furnace lined (fixed or fettled) with ore or other material rich in oxide of iron. The bath is stirred with a *rabble* to expose it to the action of the lining and of an air current. The escape of carbonic oxide causes it to boil, whence the early name of this method of puddling, viz., boiling. The term puddling, now applied in metallurgy exclusively to the above process, originally referred to the puddling of clay or clay and charcoal upon the masonry of a furnace hearth to form a lining. Ditches, reservoirs, etc., are puddled with clay to make them water-tight. 2. *See* Dry puddling. (Raymond)

Puddling furnace. A reverberatory furnace for puddling pig iron. (Standard)

Puddling machine (U. S. and Aust.). A machine used for mixing auriferous clays with water to the proper consistency for the separation of the ore. (Davies)

Puddock (Scot.). Cast-iron plate forming the crossing of flanged mine-car rails. (Barrowman)

Pudinga (Mex.). Pudding stone; conglomerate. (Dwight)

Pueblo (Mex.). The actual working of a mine. The total working force employed in a mine. A shift. (Dwight)

Puente (Sp.). 1. Any bridge of wood or metal. 2. A suspended platform in stope or shaft. 3. A stull. (Halse)

Puerta. 1. (Sp.) A door, gate; *P. de grasa*, a slag tap; *P. de plomo*, lead tap. 2. (Colom.) A timber frame or door set. (Halse)
3. *Puertas*, massive barren rocks or "horses", occurring in a vein, which must be removed to regain the pay streak. (Dwight)

Puerto (Sp.). Port or harbor. A mountain pass. (Dwight)

Puffer. Small stationary engine used for hoisting material on construction work, in operating a haulageway, or for hoisting at shallow mines, especially in prospecting and development work.

Puffer boy. A person employed to operate an engine used for hauling loaded mine cars through haulageways. (Lahti *v.* Tamarack Min. Co., 152 N. W. Rept., 907) Also the operator of any small stationary hoisting engine.

Pug. 1. (New Zealand) Selvage; clay (Power). *See also* Pugs.
2. A pug mill. 3. Tempered or pugged clay. 4. To mix and stir when wet, as clay for bricks, pottery, etc. 5. To fill or stop with clay by tamping. (Webster)

Pug engine (Scot.). A small locomotive. (Barrowman)

Pugging. The process of mixing and working clay for bricks, etc. (Century). Same as Tempering.

Pug mill. A mill for kneading or mixing clay. (Ingalls, p. 233)

Pugs (Scot.). A stratum of hard coal in a free coal seam, *e. g.*, in the Main coal seam of Lanarkshire (Barrowman). *See also* Pug, 1.

Pug tub. *See* Settler.

Puisard (Fr.). A sump. (Gresley)

Puit (Fr.). A shaft or pit. (Gresley)

Pulaskite. A variety of syenite of somewhat trachytic habit, composed of essential orthoclase and some nephelite, or sodalite, diopside, and perhaps hornblende. (LaForge)

Pulgada (Sp.). Inch; *P. de minero*, a miner's inch equal to 74 or 75 cubic meters in 24 hours. (Halse)

Pull. 1. (Eng.) To subside or settle. *See also* Creep, 1. 2. The drag in ventilation of mines. (Gresley) 3. To draw or remove the coal pillars, or pillars of ore.

Puller-off (Mid.). A man who takes the loaded trams off the cages at the surface, or who withdraws the empties from them at the bottom. (Gresley)

Pulley. A sheave or wheel with a grooved rim, over which a winding rope passes at the top of the headframe. (Gresley)

Pulley brae (Scot.). A self-acting incline. (Barrowman)

Pulley frame. A gallows frame or head frame. (Raymond)

Pulleying (Eng.). Overwinding or drawing up a cage or bucket into the pulley frame. (Gresley)

Pulley stone. The common name for a hollow cast, or mold, of the joints and stems of encrinites. (Oldham)

Pulling back (Eng.). *See* Posting.

Pulling-over rope (Eng.). A short light hemp rope for drawing the ends of winding ropes over the pulleys. (Gresley)

Pulling pillars. The common expression used for mining the coal in the pillars of a mine; robbing pillars (Steel). *See also* Pulling stumps.

Pulling stumps. The process of taking out the pillars of a coal mine (Ada Coal Co. v. Linville, 153 S. W. Rept., p. 21). *See also* Pulling pillars.

Pull-up stakes (Cal.). To strike camp. To remove from one place to another, as in search of new diggings, etc. (Hanks)

Pulmotor. A mechanical device designed to perform artificial respiration in cases of asphyxia, electric shock, drowning, etc., by exhausting the lungs and filling them with oxygen-enriched air.

Pulp (Pac.). Pulverized ore mixed with water; also applied to dry-crushed ore. (Raymond)

Pulp-assay (Pac.). The assay of samples taken from the pulp after or during crushing. (Raymond)

Pulp stone. A very large grindstone employed in pulp mills for crushing or grinding wood into fiber. (Pike)

Pulsator. 1. A machine that beats or throbs in working, as a pulsometer pump. 2. A jigger or shaking machine used in diamond mining. 3. A device that sends puffs of compressed air into either end alternately of a kind of valveless rock drill. (Webster)
4. A motor-driven air compressor that supplies compressed air to an electric channeler. It receives the exhaust from the channeling machine cylinder and thus utilizes the pressure of the exhaust. (Bowles)

Pulsator jig. A jig employing a fixed sieve and successive pulsions of rising water from a revolving plug cock with scarcely any downward return and suction. It has large capacity, occupies small space, and consumes a comparatively small amount of power. (R. H. Richards)

Pulsometer. A kind of pump, with valves, for raising water by steam, partly by atmospheric pressure, and partly by the direct action of the steam on the water, without the intervention of a piston. Also called a Vacuum pump. (Webster)

Pulverize. To reduce or be reduced to a fine powder or dust as by beating, grinding, or the like. (Webster)

Pulverulent. That which may easily be reduced to powder (Weed). Said of certain ores.

Pumice. An excessively cellular, glassy lava, generally of the composition of rhyolite (Kemp). A sort of volcanic froth. Its color is generally whitish or light gray. It is very light and will float on water. Pumice stone.

Pump. 1. Any of numerous devices or machines for raising, transferring, or compressing liquids or gases by suction or pressure or both. 2. To work or raise water, etc., with a pump. (Webster)

Pumpage. The amount raised by pumping; as, the *pumpage* of an oil-well. (Standard)

Pump bob. The balance weight used to bring up the plunger in a Cornish pumping-engine. (Standard)

Pump bucket. A packed piston having an aperture, in its center, covered by a clack or valve opening upwards. (Duryee)

Pump chamber. An underground pumping station.

Pumper. 1. (Scot.) A person who works a hand pump. (Barrowman) 2. An instrument or machine used in pumping. 3. (U. S.) An oil well that has to be pumped. (Webster)

Pump fist (Eng.). The lower end of a plunger case of a pump. (Gresley)

Pumpherston shale. A Scottish oil shale which yields 16 to 22 gallons of crude oil per ton, together with 50 to 60 pounds of ammonium sulphate. (Bacon)

Pumping. 1. The operation of filling a sludge pump by an up-and-down motion of the rods or rope. Also called Pumping the sludger. (Gresley) 2. The act of raising or transferring a liquid or gas by means of a pump.

Pumping engine. An engine used for pumping, especially a steam engine and pump combined for raising water. (Webster)

Pumping jack. A device over a deep well for operating the pump by belt power. (Webster)

Pumping shaft. The shaft containing the pumping machinery of a mine. (Standard)

Pump kettle. A convex perforated diaphragm fixed at the bottom of a pump tube to prevent the entrance of foreign matter; a strainer. (Century)

Pump ring. A flat-iron ring that, when lapped with tarred baize or coarse cloth, secures the joints of water columns. (C. and M. M. P.)

Pump rod. The rod or system of rods (usually heavy beams) connecting the steam engine at the surface, or at a higher level, with the pump piston below. (*See* Balance-bob. (Raymond)

Pump-rod plates (Scot.). Spear plates; strips or plates of iron bolted to wooden pump-rods at the joints for the purpose of making the connection. (Barrowman)

Pump slope. A slope in which pumps are operated. (Chance)

Pump sollar. A platform to give access to the door-piece and working parts of a pump. (Standard)

Pump station; Pump room. An enlargement made in the shaft, slope, or entry to receive the pump. (Steel)

Pump stock (Lanc.). *See* Pump tree.

Pump tree (Eng.). A cast-iron (wrought-iron was formerly used) pipe, generally 9 feet in length, of which the water column or set is formed. (Gresley)

Punch. 1. A tool (ram) for knocking out timbers in coal workings. (Standard) 2. Same as leg or prop. Called also Puncheon. *See* Punch prop.

Punch-and-thirl (So. Staff.). A kind of pillar-and-stall system of mining coal. (Gresley)

Puncheon. 1. (Mid.) A synonym for Prop. 2. A pointed steel tool used in marble cutting. (Webster)

Puncher. *See* Punching machine, 2.

Punching machine. 1. A machine tool used for punching holes in metals or other material. (Webster) 2. A pick machine used to undermine or shear coal by heavy blows of sharp steel points attached to a piston driven by compressed air. (Steel)

Punch prop. A short timber prop for supporting coal in holing or undercutting; a sprag. (Standard)

Pungernite. A variety of ozocerite, found in North Russia. (Mitzakis)

Puño (Mex.). Handful. (Dwight)

Punta. 1. (Mex.) Small cord for tying ore sacks. (Dwight) 2. A sharp end of an instrument, as the point of a pick. 3. *Puntas* (Peru), a crew of miners who work for 12 hours. 4. A headland or promontory. (Halse)

Puntal (Mex.). 1. Prop or post. 2. The end piece of a shaft frame. (Halse)

Puntero (Sp.). 1. A chisel used by stone cutters. 2. A gad. (Halse)

Punterola (Sp.). A short pick, chisel, or wedge used with a handle (Halse)

Puntista (Mex.). The laborer who knocks down all loose rock in the face or stope, leaving it ready for the next shift. (Dwight)

Punto (Sp.). A point; *P. de partida*, the point of discovery of a vein. The point of commencement in measuring a claim. (Halse)

Punty. In glass-blowing, a pontil. Called also Punty rod.

Puppet. *See* Poppet.

Puppet head (Eng.). *See* Poppet head.

Puppet valve. A valve that, in opening, is lifted bodily from its seat by its spindle instead of being hinged at one side. (Century)

Puppy. An underground set of pumps. (Davies)

Purbeck beds (Eng.). A fresh-water deposit consisting of various kinds of limestone and marls, immediately above the Portland beds. (Humble)

Purgar (Mex.). To blow off a boiler. (Dwight)

Purple blende. An old synonym for Kermesite. (Chester)

Purple copper ore. Same as Bornite.

Purple of Cassius. A purple precipitate formed by adding stannous chloride to chloride of gold. Used in painting and staining porcelain and glass.

Purser (Corn.). A paymaster and accountant at a mine. (Skinner)

Purufia (Peru). A shallow, earthen plate about 7 inches in diameter, used for panning small samples of ore. (Pfordte)

Pusher. A person regularly employed to push mine cars from one place to another. He usually assists the diggers to push cars up into steep rooms (Steel). *See also* Trammer and Putter.

Pushing jack. An implement for moving a large and heavy object, such as a railroad car, for a short distance. (Century) *See* Pinch, 3.

Push hole. A hole through which glass is introduced to a flattening furnace. (Standard)

Push moraine; Shoved moraine. A kind of terminal moraine consisting of material pushed along and piled into a marginal ridge. (Standard)

Put. 1. (Newc.) To convey coal from the working face to the tramway. This is usually done by young men called putters. (Raymond)
2. (Som.) A box having a capacity of from 3 to 6 cwt. of coal, used in thin seams. (Gresley)

Putter. 1. (Eng.) A man or boy who conveys coal from the working place to the tramway (Raymond). Same as Haulier, Trammer, and Drawer, 1.

Putti. A gold-washing tray used in Madras. (Lock)

Putting (Eng.). Same as hauling. (Gresley)

Putting ponies (Eng.). Ponies 10 or 11 hands high used in mines for hauling mine cars.

Put-to-stand (So. Staff.). Stoppage of coal mining on account of fire-stink. (Gresley)

Putty. 1. *See* Iron putty.
2. Tin oxide, sometimes mixed with lead oxide, used for polishing glass, metals, jewelry, etc. Called also Jewelers' putty; Putty powder. 3. In ceramics, glazing-slip. (Standard)

Putty powder. Crude oxide of tin, used for giving opaque whiteness to enamels or for grinding glass. (Raymond) *See* Putty, 2.

Putty stones. Soft pieces of decomposed rock found in placer deposits. (Power)

Put work. *See* Tutwork.

Putzen (Ger.). Small irregularly deposited spots or bunches of ore. (Davies)

Putz oil. A light distillate from Baku petroleum with a specific gravity of 0.750 to 0.770. It is used as a cleansing oil. (Bacon)

Puy. A conical hill of volcanic origin, especially in Auvergne, France, either (1) of volcanic ash or scoria with or without intervening sedimentary strata, (2) sedimentary or granitic with a cap of basalt, or (3) sedimentary, with or without volcanic ash, traversed by a dike of basalt or trachyte. (Standard)

Puzzolana; Puzzolano; Puzzolite. Same as Pozzuolana.

Pychite. A columnar variety of topaz. (Standard)

Pycnite. A variety of topaz, occurring in columnar aggregations. (Chester)

Pycnometer. A small bottle for determining the specific gravity of grains or small fragments. (Dana)

Pycnotrope. A compact mineral near serpentine; probably an alteration product. (Chester)

Pyramid. 1. In crystallography, strictly, (*a*) in the tetragonal, hexagonal, and and orthorhombic systems, an open form of three, four, six, eight, or twelve faces which meet the vertical axis in a common point; (*b*) in the monoclinic and triclinic systems, an open form of one, two, or four faces which cut all three axes. 2. As gen-

erally used, a form enclosed by all the faces answering the above description whose intercepts have the same ratio; hence, a double-ended pyramid having both ends alike; better called a bipyramid. (La Forge)

Pyramidal garnet. Idocrase (Power). A variety of Vesuvianite.

Pyramidal stoping. *See* Rill stoping.

Pyrargyrite. Dark, ruby silver. Silver-antimony sulphide, $3Ag_2S.Sb_2S_3$. Contains 59.9 per cent silver when pure, but analyses show from 57 to 60.9 per cent. (U. S. Geol. Surv.)

Pyrene. A hydrocarbon, $C_{16}H_{10}$, obtained from coal tar. (Bacon)

Pyrite. A hard, heavy, shiny, yellow mineral, FeS_2, generally in cubic crystals. It may be distinguished from chalcopyrite by being of a paler yellow, harder and giving a black powder, whereas chalcopyrite gives a yellow powder. Marcasite has the same composition, but is white and crystallizes differently. (Roy. Com.) Isometrically crystallized iron disulphide, FeS_2. Contains 46.6 per cent iron. (U. S. Geol. Surv.) Also called Iron pyrites, Fool's gold, Iron sulphide.

Pyrites. The term *pyrites*, as frequently used, literally means a mineral that strikes fire. It is applied to any of a number of metallic-looking sulphides, of which iron pyrites (pyrite) is the commonest; as copper pyrites (chalcopyrite), tin pyrites (stannite), etc. The term *pyrite* applies only to the iron disulphide, FeS_2.

Pyritic. Of, pertaining to, resembling, or having the properties of pyrite. (Standard)

Pyritic smelting. The fusion of sulphide ores by the heat generated by their own oxidation, and without the aid of any extraneous heat, such as carbonaceous fuel, the electric arc, etc. (Peters', p. 372.)

Pyritiferous. Containing or producing pyrite. (Webster)

Pyritization. Conversion into pyrite either by simple replacement or by alteration, or both. (Standard)

Pyritize. To convert into pyrite. (Webster)

Pyritohedron. The pentagonal dodecahedron. (Webster)

Pyritology. 1. The science of blowpipe analysis. (Webster)
2. Facts or information relating to pyrite. (Century)

Pyrobitumen. A dark-colored, solid, infusible, natural-hydrocarbon complex, often associated with a mineral matrix, insoluble in water, and relatively insoluble in carbon disulphide, benzol, etc. (Bacon)

Pyrobituminous. Yielding bituminous products on heating, as coal. (Webster)

Pyrochlore. Chiefly a niobate of the cerium metals, calcium and other bases, with also titanium and thorium. Probably essentially a metaniobate with a titanate, $RNb_2O_6.R(Ti,Th)O_3$; fluorine is also present. (Dana)

Pyrochroite. Manganese hydrate, a mineral occurring in foliated forms with pearly luster, resembling brucite. It is white when fresh, but changes to bronze and black upon exposure. (Century)

Pyrocalstic. Of igneous origin and fragmental texture: said of some rocks, as tuff, agglomerate, volcanic breccia, etc. (La Forge)

Pyrocrystalline. Crystallized from a molten magma. (Webster)

Pyrogen. An obsolete term for electricity. (Webster)

Pyrogenous. Formed by fusion; igneous; as, *pyrogenous* rocks. (Standard)

Pyrognostics. The characters of a mineral observed by the use of the blowpipe, as degrees of fusibility, flame coloration, etc. (Webster)

Pyrolite. An explosive resembling gunpowder in composition. (Webster)

Pyrolites. A term employed by M. E. Wadsworth to comprise all mineral refractory or fire-resisting materials. (Power)

Pyrolusite. Black oxide of manganese. Manganese dioxide, MnO. Contains 63.2 per cent manganese. (U. S. Geol. Surv.)

Pyromagnetic. Pertaining to, produced by, or acting by the combined agency of, heat and magnetism. (Webster)

Pyromeride. A name given by the Abbe Haüy to the orbicular diorite or corsite of Corsica. The word means "partly fusible," and refers to the properties of the two constituent minerals, of which the one, quartz, was infusible, and the other, the feldspar, could be melted. (Kemp)

Pyrometallurgy. Metallurgy depending on the action of heat, as in smelting.

Pyrometamorphism. Metamorphism produced by heat: contrasted with Hydrometamorphism. (Standard)

Pyrometer. 1. An instrument for measuring the expansion of solid bodies by heat. 2. Any instrument for measuring degrees of heat, especially above those indicated by the mercurial thermometer. (Webster)

Pyrometer cone. One of a series of small cones of different substances forming a scale of fusing points, and used in finding approximately the temperature of kilns, etc. (Webster)

Pyrometry. The art of measuring degrees of heat; the art of using a pyrometer. (Webster)

Pyromorphite; Green lead-ore. Chlorophosphate of lead, $3Pb_3P_2O_8.PbCl_2$. (U. S. Geol. Surv.)

Pyromorphous. Crystallizing from a molten state. (Webster)

Pyronaphtha. A heavy illuminating oil obtained from Russian petroleum. It has a light-yellow color and a specific gravity of 0.840 to 0.860. (Bacon)

Pyronome. An explosive containing the ingredients of gunpowder, and also antimony, potassium chlorate and chromate, and flour. (Webster)

Pyrope. Magnesium-aluminum garnet, $3MgO.Al_2O_3.3SiO_2$. Color deep red to nearly black. Used as a gem when transparent. (U. S. Geol. Surv.)

Pyrophane. A variety of opal that by the absorption of melted wax is made translucent when hot, but becomes opaque again on cooling. (Standard)

Pyrophyllite; Pencilstone. A hydrous aluminum silicate, $H_2O.Al_2O_3.4SiO_2$. Resembles talc in color, feel, luster, and structure. Used for slate pencils and for the "talc" or "talcum" of commerce. (U. S. Geol. Surv.)

Pyrophysalite. Same as Physalite. A coarse, nearly opaque, variety of topaz. (Dana)

Pyropissite. An earthy, friable, coaly substance, of a grayish-brown color and having a specific gravity of 0.493 to 0.522; it melts easily to a pitch-like mass and affords 62 per cent of paraffin on dry distillation. (Bacon)

Pyroretin. A resin that occurs in brown coal, near Aussig in Bohemia; it is brittle, of a brownish-black color, and has a specific gravity of 1.05 to 1.18. (Bacon)

Pyroschist. A schist or shale containing sufficient hydrocarbons to burn with a bright flame, or one yielding volatile hydrocarbon or inflammable gas when heated. (Century)

Pyrosphere. *See* Barysphere.

Pyrostat. A thermostat, especially one for measuring high temperature. (Webster)

Pyrostibite. An old synonym for Kermesite. (Chester)

Pyrostilpnite. A hyacinth-red variety of pyrargyrite, $Ag_3S.Sb_2S_3$. (Dana)

Pyroxene. A metasilicate, chiefly of calcium and magnesium, also iron, less often manganese and zinc. There are a number of varieties. *See* Diopside, Hedenbergite, Augite, (Dana). The name of the mineral is often prefixed to the name of the rocks that contain it.

Pyroxenite. A granular, igneous rock, consisting essentially of pyroxene, with or without hornblende, spinel, and iron oxides, and with little or no feldspar or olivine. (La Forge)

Pyrrhotite; Magnetic pyrites. A variable iron sulphide, Fe_nS_{n+1}. Many pyrrhotites contain nickel and are mined as nickel ores (U. S. Geol. Surv.). It has a reddish-brown color, and is magnetic, hence magnetic pyrites. (Dana)

Q.

Quadrant. 1. The quarter of a circle; an arc of 90°. 2. Any of the four parts into which a plane is divided by rectangular coordinate axes lying in that plane. 3. An instrument for measuring altitudes. 4. A device resembling a bell crank for converting the horizontal reciprocating motion of an engine piston rod into the vertical up-and-down movement of a pump rod. 5. A unit of length equal to 10,000 kilometers. (Webster)

Quadrel. 1. A square brick, tile, or stone; especially, a whitish air-dried brick made of chalky earth. 2. (Prov. Eng.) A square of peat or turf. (Standard)

Quadrune. A gritstone with a calcareous cement. (Standard)

Quagmire. Soft, wet, miry land, that shakes or yields under the foot. (Webster)

Quaking bog. A bog that shakes under foot, consisting of growing peat saturated with water. (Standard)

Qualitative analysis. The process, in chemistry, of finding how many and what elements are present. (Standard)

Quantitative analysis. The process, in chemistry, of finding the bulk or amount of each element present. Called also Elementary analysis (Standard). Both the volumetric and gravimetric methods are included in this process.

Quaquaversal. Dipping outward in all directions from a central point: as a dome in stratified rocks. (La Forge)

Quar; Cliff quar (Forest of Dean). An indurated clay. *See* Bind, 1. (Gresley)

Quarey lode. *See* Quarry lode.

Quarl; Quarle. A large brick or tile; especially a curved firebrick used to support melting pots, retort covers, or the like. (Webster)

Quarman. An obsolete term for a quarryman. (Standard)

Quarpit. An obsolete term for a quarry. (Standard)

Quarrel. 1. A stone quarry. 2. Materials from a quarry. An obsolete term. (Standard)

Quarrier. A workman in a stone quarry; a quarryman. (Standard)

Quarry. 1. An open or surface working, usually for the extraction of building-stone, as slate, limestone, etc. (Raymond)
2. (Eng.) An underground excavation formed in the roof or fault, for the purpose of obtaining material for pack walls. (Gresley)
Note: In its widest sense the term *mines* includes *quarries*, and has been sometimes so construed by the courts; but when the distinction is drawn, *mine* denotes underground workings and *quarry* denotes superficial workings. Open workings for iron ore, clay, coal, etc., are called *banks* or *pits* rather than quarries (Webster), the latter being defined as in 1 above.

Quarry bar. A horizontal bar supported at each end by legs and used to carry machine drills. (Gillette, p. 97)

Quarry face. The freshly split face of ashlar, squared off for the joints only, as it comes from the quarry, and used especially for massive work. (Webster)

Quarrying-machine. Any machine by which to drill holes or cut channels in native rock; a gang-drill, rock-drill, or tunneling machine, but most commonly a small form of locomotive, bearing rock-drilling mechanism, and operating on a track laid temporarily along or opposite the ledge to be cut. (Standard)

Quarry lode (Corn.). A lode or stratum that breaks in large hard blocks, by reason of joint planes. (Pryce)

Quarry machine. *See* Quarrying machine.

Quarryman. A man engaged in quarrying stones; a quarrier. (Webster)

Quarrymaster (Scot.). The owner of a quarry. (Barrowman)

Quarry-stone bond. Rubble work. (Webster)

Quarry water. Water that fills the pore spaces of a rock as it lies in its original bed (Bowles). *See* Ground-water.

Quartation. The separation of gold from silver by dissolving out the latter with nitric acid. It requires not less than ¾ silver in the alloy, whence the name, which is also applied to the alloying of gold with silver, if necessary, to prepare it for this method of parting. (Raymond)

Quarter coal (York.). Same as Colliers' coal.

Quarter cord (Derb.). A cord or chain one-quarter of a mere in length (about 7½ yards), used in measuring mineral ground. (Mander)

Quartering. A method of reducing an ore sample by discarding alternate quarters after the ore has been spread on the floor. The operation is repeated until a large sample has been reduced to a few pounds. (Hofman, p. 48)

Quartering-in (Lanc.). A plan of building or putting together tubbing plates from the top downward, the rings and segments being bolted together as the work of excavation proceeds. (Gresley)

Quartering-way (Corn.). A quarry term to designate a direction in which a rock cleaves with moderate facility. (Greenwell, p. 80)

Quarternary. The later of the two geologic periods comprised in the Cenozoic era, in the classification generally used. Also the deposits

formed during that period. (It comprises all geologic time and deposits from the end of the Tertiary until and including the present. It has also been called Post-Tertiary and Pleistocene, but Pleistocene is now generally restricted to the earlier part of the Quarternary.) (La Forge)

Quarternary steel. An alloy steel that contains two alloying elements, such as chromium-vanadium steel (Hibbard). It contains two elements plus the iron and carbon, hence quarternary.

Quarter line (Western U. S.). The original survey-line by which a section of Government land is divided into four parts. (Standard)

Quarter-point veins (No. of Eng.). Small veins having an intermediate bearing between strike and cross veins. (Power)

Quarter post (Western U. S.). A halfway post between two section-corners on the same line of a surveyed section of land. (Standard)

Quarter section. In the Government system of land surveying in the United States and Canada, a tract of land half a mile square and containing 160 acres. (Webster)

Quartz. 1. Crystallized silicon dioxide, SiO_2. *Amethyst* is a variety of the well-known amethystine color. *Aventurine* is a quartz spangled with scales of mica, hematite, or other minerals. *False topaz* or *citrine* is a yellow quartz. *Rock crystal* is a watery clear variety. *Rose quartz* is a pink variety. *Rutilated quartz* contains needles of rutile. *Smoky quartz* is a brownish variety, sometimes called *cairngorm*. *Tiger-eye* is crocidolite (an asbestos-like mineral) replaced by quartz and iron oxide and having a chatoyant effect. (U. S. Geol. Surv.)
The name of the mineral is prefixed to the names of many rocks that contain it, as quartz-porphyry, quartz-diorite. (Kemp)
2. (Pac.) Any hard, gold or silver ore, as distinguished from gravel or earth. Hence, quartz-mining, as distinguished from hydraulic mining, etc. (Raymond)

Quartz battery (Aust.). A quartz-mill. (Standard)

Quartz boil. An outcrop of a quartz reef. (Duryee)

Quartz bucket. A bucket for hoisting quartz. (C. and M. M. P.)

Quartz claim. In the United States, a mining claim containing ore in veins or lodes, as contrasted with placer claims, carrying mineral, usually gold, in alluvium.

Quartz drift. Any loose rock material containing quartz fragments as a prominent constituent. *See* Drift, 6. (Century). A mine opening in a quartz-bearing rock.

Quartzic. Same as Quartziferous.

Quartziferous. Consisting chiefly of quartz. (Milford)

Quartzite. A metamorphosed quartz sandstone, formed by the deposition of secondary silicia between the original grains, so that the rock is more firmly cemented and less porous than before and tends to break across the grains (La Forge). Not to be used for vein quartz (Kemp). Called also Quartz-rock, Granular quartz.

Quartzitic. Of, pertaining to, or consisting of quartzite or quartz. (Century)

Quartz liquefier. An apparatus in which, by the action of an alkali and high-pressure steam, gold-bearing quartz is converted into a soluble silicate from which the gold may be separated by washing. (Standard)

Quartz mill. A machine or establishment for pulverizing quartz ore, in order that the gold or silver it contains may be separated by chemical means (Standard). A stamp mill.

Quartz mine. A mine in which the deposits of ore are found in veins or fissures in the rocks forming the earth's crust (Duryee). *See* Quartz mining. Usually applied to lode gold mines, but not to placers.

Quartz mining. Mining on veins or ore bodies in place, as distinguished from surface digging or washing (alluvial or placer mining); underground mining in rock; so called because quartz is the chief mineral associated with gold in such deposits. (Webster)

Quartz monzonite. An igneous rock of granular texture containing quartz with orthoclase and plagioclase in about equal proportions. (Ries)

Quartzoid. A crystal having the form of two six-sided pyramids base to base. (Standard)

Quartzose. Containing quartz as a principal ingredient. (Raymond)

Quartz porphyry. Any porphyritic rock in which the quartz occurs as phenocrysts.

Quartz reef. A lode or vein of quartz (Duryee). *See also* Reef.

Quartz reefer (Aust.). One engaged in mining for gold in a quartz reef or vein. (Webster)

Quartz rock. *See* Quartzite.

Quartz sinter. Siliceous sinter. (Century)

Quartz vein. A deposit of quartz in the form of a vein. Auriferous veins are often called quartz veins, and mining for gold in the rock is called quartz mining. (Century)

Quartz wedge. In mineralogy, a wedge-shaped piece of quartz used in optical work. (A. F. Rogers)

Quebec City series. Same as Quebec group. (Standard)

Quebec group. A series of strata near Quebec, Canada, formerly supposed to be intermediate in age between the Calciferous and the Chazy, but now known to include beds from the Pre-Cambrian to the lower Silurian. (Standard)

Quebrada (Sp.). 1. A valley; a ravine. 2. A fissure or break in stratified rocks. 3. Broken or uneven ground. 4. A stream. (Halse)

Quebrador (Mex.). 1. An ore breaker or cobber. 2. A sledge used in cobbing. (Halse)

Quebrar (Sp.). To cob, break or crush ore. (Halse)

Quebrazón de veta (Mex.). A break in a vein. (Dwight)

Quebrith. An obsolete term for sulphur. (Standard)

Queen's metal (Corn.). An alloy consisting of nine parts of tin and one each of antimony, bismuth and lead. (Crofutt)

Queen's ware. Glazed English earthenware of a cream color; cream-colored wedgewood ware. (Webster)

Queen's yellow. The yellow subsulphate of mercury. (Century)

Queer (Prov. Eng.). A fissure, joint, or small cavity, as in a rock or vein of quartz (Standard). Also spelled Quere, Queere and Qweear.

Queer creek. A fine-grained sandstone found in Ohio and used in the manufacture of inexpensive sharpening stones. (Pike)

Queery (Corn.). When the lode or rock on which the miner is driving partakes of the character of quarry stone, *viz.*, in detached lumps by natural divisions, it is called *queery ground*, and is frequently worked with crowbars and levers instead of being blasted or gadded. A "queer of ground" is a detached rock (Hunt). Also called Quarry lode. *See also* Queer.

Quema; Queme (Mex.). 1. A roast of ore; the process of roasting ore; retorting amalgam. (Dwight) 2. Calcining of mercury ores in clay retorts. 3. *Metal de quema* (Peru), a sulphide ore. (Halse)

Quemadero (Mex.). A burning place; a retorting furnace for silver or gold amalgam. (Dwight)

Quemado (Mex.). Literally, burnt stuff. Any dark, cindery looking mineral encountered in a vein or mineral deposit (generally manganiferous). (Dwight)

Quemar (Sp.). To calcine or roast ore; *Q. piedra*, to heat a stone and then drop it in water in order to break it. (Halse)

Quemazón. 1. (Peru) Silver ore containing black peroxide of manganese. 2. (Mex.) An outcrop. (Dwight)

Quench. 1. To cool suddenly, as heated steel, in tempering. (Webster) 2. To produce a crust or succession of crusts on (molten metal), each crust being removed as it is formed. (Standard)

Quenching. Specially, in copper-refining or the like, the act of cooling the surface of molten metal, and causing the formation of rosettes in the crust, by pouring water into the crucible. (Standard)

Quenching pit. A pit filled with water in which graphite, residue of iron, and slag from hot-metal ladles is granulated so that it will pass through bin doors when it is recharged into furnace. (Willcox)

Quenching tub. A tub of water in which to cool, harden, or temper iron or steel. (Standard)

Quergestein (Ger.). Strata crossed at right angles by a lode. (Davies)

Quesos. 1. (Peru). Pressed amalgam cakes. (Pfordte)
2. (Mex.) In the *patio* process small cakes of silver resulting from smelting sulphides with litharge in small clay furnaces. (Halse)

Quick. 1. Applied to a productive vein as distinguished from dead or barren. An ore or pay streak is said to be quickening when the associated minerals indicate richer mineral ahead. 2. (Pac.) A local term for quicksilver. (Raymond)
3. Soft water-bearing strata, such as running sand. 4. (So. Staff.) Solid or ungotten coal forming the roof of a roadway in a "thick coal" colliery. 5. Blasting powder is said to be "quick" when it burns or goes off very rapidly. (Gresley)
6. In electroplating, to wash with quicksilver or other substance that insures the adhesion of a coating of silver. (Standard)

Quickening liquid. A solution of a salt of mercury, usually the nitrate or cyanide, in which the articles to be plated with silver are plunged before being put into the silver bath. A thin film of mercury is formed which insures a perfect adhesion of the silver coating (Webster). *See also* Quick, 6.

Quick ground. Ground in a loose, incoherent state. (Raymond)

Quicklime. Calcined calcium carbonate (limestone). By the addition of water it slakes and forms hydrate of calcium.

Quickness. The property of an explosive by virtue of which it exerts a sharp blow or shattering effect on the material with which it is in contact. The quickest explosive of the dynamite class is the 60 per cent. straight dynamite. Quick explosives are the ones particularly desired for mudcapping. For maximum effect for this purpose, they should be of high density and sensitiveness. (Du Pont) *See also* Quick, 5.

Quicksand. Sand which is (or becomes, upon the access of water) "quick," *i. e.*, shifting, easily movable or semi-liquid. (Raymond)

Quicksandy. Containing or abounding in quick sands. (Century)

Quicksilver. 1. A common name for mercury; one of the metallic elements, remarkable for its low melting point, being liquid down to minus 40° F. (Roy. Com.)
2. To overlay with quicksilver, or with an amalgam of quicksilver and tin. (Webster)
3. An amalgam of tin, used for the reflecting surface of mirror. (Standard)

Quicksilver cradle. A wooden box placed in a sloping position, and fixed upon rockers, in which gold-bearing gravel is washed, the gold being caught by mercury in the lower part of the cradle. (Davies)

Quicksilvering. The process of coating or treating with quicksilver. (Standard). *See* Quicksilver, 3.

Quicksilver rock (Calif.) A dark opaline or chalcedonic rock, commonly associated with cinnabar and often indicative of the presence of this quicksilver mineral. (Webster)

Quicksilver water. *See* Quickening liquid.

Quick water. A dilute solution of nitrate of mercury and gold, used in the process of water-gilding. (Century)

Quiebra (Sp.) 1. The breaking or crushing of ore by hand or machinery. 2. A fault, fracture or break in rocks. (Halse)

Quijadas (Mex.). Rock breaker; jaw plates. (Dwight)

Quijo (Sp.). Gangue, or vein rock. (Halse)

Quilatar; Aquilatar (Sp.). To assay gold or silver. (Halse)

Quilate (Sp.) 1. The degree of purity of gold or precious stones. 2. A carat. (Halse)

Quill. A slow burning fuse made formerly of the quill of a feather filled with powder. (Standard)

Quimbalete (Peru). *See* Bimbalete.

Químico (Mex.). Chemist or assayer. (Dwight)

Quintal. A denomination of weight; a hundredweight. In the metric system, 100 kilograms; in the United States and Great Britain 100 (or 112) pounds avoirdupois; in Spain 100 libras, or 46.09 kilograms; in Colombia 100 libras or 50 kilograms; in Portugal and Brazil, 58.752 kilograms (Webster). In Mexico, 46.-0246 kilograms. (Dwight)

Quintaleros (Bol.). Native lessees who treat copper ore in *quimbaletes*. (Halse)

Quinto (Sp.). Mining tribute from American colonies to the King of Spain (Dwight). As originally levied by Ferdinand and Isabella it amounted to 20 per cent, but was later reduced.

Quitapepena (Mex.). A guard who searches the miners as they come out of the mine to prevent stolen ore being taken from the mine. (Halse)

Quitclaim. A release or relinquishment of a claim; a deed of release. In the United States it is more than a release and is used as a simple conveyance for making a grant of lands. (Webster)

Quoiceneck (Shrop.). Grayish black clay with streaked shining surfaces. (Gresley)

Quoin. 1. The keystone or a voussoir in an arch. 2. A wedge to support and steady a stone. (Webster)
3. A large square ashlar or stone at the angle of a wall to limit the rubble and make the corner true and strong. 4. One of the four facets on the crown, on the pavilion, or on the base of a gem (Standard)

Qweear; Queere. (Corn.). A small cavity or fissure (Raymond). *See also* Queer; Queery.

R.

Rabat. Imperfectly baked potters' clay: used as a polishing material. (Standard)

Rabban (Corn.). A dry yellowish gossan. (Power)

Rabble. 1. An iron scraper serving for a rake in removing scoriæ from the surface of melted metal in a reverberatory furnace. It has generally an iron handle ten or fifteen feet in length. The iron scraper is about a foot long and from four to six inches wide (Jackson). *See* Puddling.
2. A charcoal burner's shovel. 3. A mechanical stirrer used to stir the ore charge in roasting furnaces. (Webster)

Rabbler. 1. A rabble (which *see*). 2. One who uses a rabble, as in puddling iron. 3. A scraper. (Standard)

Rabbling. Stirring a charge of ore in a reverberatory furnace with a specially designed iron rod. (C, and M. M. P.)

Rabbling tool. A rabble of simple construction for use by hand (Standard). *See* Rabble, 1. Also called Rabble rake.

Rabot. A hardwood block used in polishing marble. (Standard)

Race. 1. (Scot.) *See* Journey, 1. 2. (Eng.) The space in which a winding drum revolves. (Gresley)
3. To scrape the face of a grindstone so as to make it cylindrical and abrasive. 4. A watercourse made and used for industrial purposes, as for mining. (Webster)
5. A small thread of spar or ore. (Raymond)
6. (Scot.) A set or train of hutches coupled together. (Barrowman)

Rack (Corn.). An inclined frame on which ores are washed (Whitney). A stationary buddle. Also spelled Reck.

Rackarock. An explosive consisting of about four parts of potassium chlorate to one part of nitrobenzine. (Century)

Racking. 1. The process of separating ores by washing on an inclined plane. (Davies)
2. Act of leaving an uncompleted part of a wall with bricks or stones stepped in and out, so that more may be bonded to it. (Webster)
3. Same as Ragging. (Standard)

Racking table. A table on which to wash ore slimes (Standard). *See* Rack, 1.

Rackings (Scot.). *See* Corner rackings.

Rack railroad. A cog railway, or cog tramway.

Raddle (York.). 1. Earthy hematite occurring in the coal measures. (Gresley). *See* Reddle.
2. A rabble. (Standard)

Radial dikes. A descriptive term specially used by L. V. Pirsson for those dikes that radiate outward from an eruptive center. (Kemp)

Radian. An arc of a circle equal to the radius, or the angle at the center measured by it. Its value is 57.2958+ degrees. (Webster)

Radiated. Applied to crystal aggregates that radiate from a center without producing stellar forms. (Dana)

Radiated pyrite. Marcasite. (Power)

Radiation. Emission and diffusion of rays, as of light or heat. (Webster)

Radical. An atom or element, or a group of atoms or elements, that is the chief constituent of the molecules of a given compound or that will not decompose in the ordinary chemical reactions to which a compound is liable; more specifically, a group of different atoms acting as a single element in a compound and incapable of independent existence, as NH_4 (ammonium) in NH_4Cl (ammonium chloride), or C_2H_5 (ethyl) in C_2H_5HO (ethyl hydrate or alcohol). (Standard)

Radioactive. Capable of emitting, spontaneously, rays consisting (at least in part) of material particles traveling at high velocities. (Webster)

Radiolite. A variety of natrolite, especially that from southern Norway. (Standard)

Radiometallography. The application of X-rays to the study of the internal structure of various materials, especially metals. For details *See* THE ENGINEER, London, July 25, 1919.

Radium. A metallic element, Ra, derived, through a series of intermediate elements, from uranium. It gives off helium (the α rays) and charges of niton. Successive alterations give other elements, part of which radiate β and γ rays. Radium is never found in sufficient quantity to be visible, but occurs with and only with uranium minerals. From these it is separated to obtain the radium salts of commerce. *See* Uranium. (U. S. Geol. Sury.) Atomic weight, 226.0.

Radium vermilion. A red lead coated with an organic color. (Webster)

Raedera (Sp.). 1. A semicircular rake for collecting mineral. 2. A rake used in metallurgical operations. (Halse)

Raff. The coarse ore after crushing by Cornish rolls. (C. and M. M. P.)

Raffain (Corn.). Poor ore. (Power)

Raff wheel. A revolving wheel with side buckets for elevating the raff. (C. and M. M. P.)

Raff yard (No. of Eng.). A walled-in yard on the surface, in which the smiths, wrights, carpenters, etc., work. (Gresley)

Rafter timbering. A method of mine timbering in which the timbers appear like roof-rafters. (Thiseng)

Rag. 1. (Eng.) Any of various hard rocks used for whetstones; a hard limestone used in building; a basaltic rock, shale, etc. 2. A kind of roofing slate. 3. To break ore into lumps for sorting; to cut or dress roughly, as a grindstone. (Webster)

Rag-and-chain pump (Eng.). An early type of chain pump in which rags were tied on the chain in place of rubber or metal buttons. Used in draining coal pits. (Gresley)

Rag-burn (Corn.). To subject the product of the first dressing of tin ores to a first or partial roasting. (Raymond)

Ragging. A rough cobbing. (Raymond)

Raggling (Scot.). A channel cut in the side of a mine and covered with boarding to serve as an airway. (Barrowman)

Rag pump; Rag-wheel pump (Corn.). A chain pump. (Davies)

Ragstone. 1. Any hard, coarse-textured rock. (Power)
2. Especially, a rough, sandy, fossiliferous limestone of the Lower (Bath) Oölite in England. 3. Stone quarried in thin slabs, as for pavements. (Standard)

Rag wheel. 1. A sprocket wheel; a chain wheel. 2. A polishing wheel made of disks of cloth clamped together. (Webster)

Ragwork. Masonry built with undressed flat stones of about the thickness of a brick and having a rough exterior, hence the name. (Century)

Rail bender. A screw-press or hydraulic-press for straightening rails, or for bending them in the construction of railway curves and switches (Century). Used also in underground tram roads.

Railroad powder. An explosive consisting of assorted grains, similar to gunpowder, made in such a way that the grains are not porous, having nitroglycerin on the surface not absorbed by the grain (Du Pont). Abbreviated R. R. P.

Rail train. A train of rolls for reducing iron or steel ingots or blooms to rails. (Raymond)

Rain (Mid.). Water dropping freely from the mine roof. (Gresley)

Rainbow chalcedony (Eng.). A variety of chalcedony of thin concentric layers, which when cut across exhibit an iridescence resembling the colors of the rainbow. (Page)

Rain chamber. A chamber in which fumes, as from molten metal, may be condensed by a water shower. (Standard)

Rain channel. In geology, a miniature furrow on a rock surface carved by the rain. (Standard)

Rain print. The impression of a raindrop on recent mud, or fossil on the surface of ancient strata. (Standard)

Rain-spot slate. A mottled Lower Silurian slate of Wales. (Standard)

Raise. 1. To cause to rise, or expand upward. (Webster)
2. (Eng.) To wind coal, etc., to the surface. (Gresley)
3. To take up the floor or bottom rock in a room, gangway, or entry to increase the height for haulage.
4. A mine shaft driven from below upward; called also *Uprâise*, *Rise* and *Riser* Webster). An opening, like a shaft, made in the back of a level to reach a level above. (Standard). The term is in general usage at mines in Western States. *See* Rise, 1.

Raised beach. A shelf or terrace of shingle, gravel, and sand elevated above the present level of the lake or sea in which it was formed, and indicating a change in the relative level of land and water surface. (Century)

Rait; Rate (Mid.). To split off the walls or sides of underground workings (Gresley). Called Rosh in Leicestershire.

Rajas (Mex.). Lagging (half round). (Dwight)

Rajos (Chile). Open-cast workings. (Halse)

Rake. 1. (Mid.) To smother a ventilating furnace with fuel, so that it smolders for many hours. 2. (Mid.) An iron rake with a short handle, with which fillers fill baskets or pans. 3. (Derb.) A series of beds of clay ironstone lying within a few feet or yards of one another, making a workable ironstone. (Gresley)
4. (Derb.) A fissure vein crossing the strata (Raymond). Also called Rake vein.
5. The inclination of anything from the vertical. Said of mineral veins, faults, etc.
6. *See* Race, 6.

Rake of skips (Aust.). A number of skips connected that form a set or train (Power). A trip. *See* Race, 8.

Rakers. 1. Slanting props placed at the end of a drift set to keep the timbers steady when blasts go off. (Sanders, p. 111)
2. (Eng.) Shots placed round a sumper shot. (Gresley)

Rake vein. 1. (Derb.) In lead-mining, a vertical or highly inclined vein, as distinguished from a flat vein, or pipe vein (Century). *See* Rake, 4 and 5.
2. A vein or lode cutting through the strata. (Skinner)

Raking coal (Eng.) A large lump of hard coal placed upon a fire or ventilating furnace, for the purpose of just keeping it burning, or rather smoldering, when a larger fire is not required. (Gresley)

Raking prop. An inclined prop (Raymond). *See* Rakers, 1.

Rakuware. A Japanese earthenware of the 15th or 16th century, rough and with a dark glaze. (Webster)

Raky system. A percussion drilling system designed by Engineer Raky, a Russian. Although it is at present considered a little old-fashioned, it is still in use in some parts of the Taman Peninsula and Crimea. (Mitzakis)

Ram. 1. The plunger of a pump. 2. A device for raising water. (C. and M. M. P.)
3. *See* Barney. 4. A mechanical device for pushing hot coke out of an oven. (Power).

Rama (Sp.). A branch, as a branch road; a branch vein. (Halse)

Ramal (Sp.). 1. The principal passage in a mine. 2. A branch vein. (Halse)

Ramalear (Sp.). To branch off into various divisions. (Dwight)

Ramble (Newc.). A shale bed on the top of a coal seam, which falls as the coal is removed. (Raymond)

Rammelly (Mid.). Mixed argillaceous and sandy rocks. (Gresley)

Rammelsbergite. Essentially nickel diarsenide, $NiAs_2$, like chloanthite. (Dana)

Rammer. A founder's implement for compacting material in the mold, etc. (Standard)

Ramming bar (No. of Eng.). A beater (Pryce). A tamping or stemming bar or rod.

Rana (Sp.). A railway frog. *See also* Sapo. (Halse)

Rance. 1. (Scot.) A long narrow pillar of coal. 2. A prop set against the coal face that is undermined. (Barrowman)
3. (Fr.) A dull red marble with blue and white markings, from Belgium, and sold in the United States as Belgian marble. (Webster)

Rand (Dutch). A range of hills. (Duryee). *The Rand* is a rocky gold-bearing ridge in South Africa, about 30 miles long, on which Johannesberg is situated; also the gold-mining district including this ridge. (Webster)

Randanite. A synonym for Kieselguhr. The name is used in France. (Century)

Randolph process. A modification of the series process of copper refining in which the electrodes lie horizontally, the top surface of each one acting as anode, the lower as cathode. Theoretically it has the advantage of extremely low metal losses and great purity of copper. Practically, it is difficult to right matters in a tank after a short circuit. *See* Hayden process and Smith process. (Liddell)

Random. The direction of a rake vein. (Raymond)

Random courses. Courses of masonry in which the stones are of different thicknesses, though dressed and fitted. (Standard)

Random rubble. Uncoursed rubblework. (Standard)

Random stone. A term applied by quarrymen to quarried blocks of any dimensions. (Perkins)

Random work. Stonework laid in random courses. (Standard)

Rang (Ceylon). Gold; from *rangwelle*, golden sand. (Lock)

Range. 1. A chain of mountains or hills. 2. A belt or strip of country within which certain economic minerals are supposed to occur or run. (Roy. Com.)
3. In the Lake Superior region, a term applied to a deposit of iron ore and the associated rocks. It originated from the finding of ridges or ranges formed by the wearing of the softer rocks while the hard rocks in which the iron ore is found made ridges, or low ranges. Now the term simply means deposits of iron ore, which are all known as "ranges," even if the ground where they occur be low swamps. (Min. and Sci. Press, Aug. 28, 1915, p. 327)
4. In the public land system of the United States, a row or line of townships lying between two successive meridian lines six miles apart. The meridians which are included in each great survey are numbered in order east and west from the "principal meridian" of that survey, and the townships in the range are numbered north and south from the base line which runs east and west. (Webster)
5. (Scot.) A row, as of pillars. (Barrowman)

Range coal (Iowa). Small lump coal.

Range pole. A long wooden staff, usually painted alternately red and white at one foot intervals and used by surveyors for long sights. *See* Picket.

Range work. Ashlar masonry laid in horizontal courses of even height. (Webster)

Ranging. 1. (Scot.) Searching for minerals by means of shallow pits across the outcrops. (Barrowman)
2. (Eng.) Laying out the line of the tunnel (Simms). *See also* Alignment.

Ranging rod. *See* Range pole.

Rangoon oil. The trade-name for a semisolid or butter-like petroleum from Upper Burma, refined at one time in England. (Bacon)

Rankine's cycle. A nonreversible heat-engine cycle differing from Carnot's cycle in having no compression. The steam-engine cycle is approximately a Rankine cycle. (Webster)

Raoult's law. The principle that molecular quantities of different substances dissolved in the same amount of solvent equally depress the freezing point. It does not hold for electrolytes owing to dissociation. (Webster)

Rap. 1. To warn men in an adjoining working place, of a blast when the working places are separated by only a small pillar, by knocking on the pillar with a tool or bar. 2. To signal by knocking on a steam, water, or air pipe. 3. To test the roof by tapping it with a stick or bar.

Rap-in (Som.). To wedge down blocks of stone in underground quarries. (Gresley)

Rappage. Excess in size of a casting because the mold is larger than the pattern when the latter is unduly rapped, as with the hand, for drawing. (Standard)

Rapper. 1. A lever or hammer at the top of a shaft or inclined plane for signals from the bottom. (Raymond)
2. (Mid.) The upper end of the vertical arm of a staff used for gaging the depth of holing. (Gresley)

Rarefaction. The process or act of making rare or less dense; increase of volume, the mass remaining the same: now usually of gases; also, the state of being rarified; as the *rarefaction* of the atmosphere on a high mountain. (Standard)

Rascar (Sp.). To scratch (or search) for valuable mineral on the surface of abandoned mines. (Halse)

Raschette furnace. A shaft furnace used in lead, copper, and iron smelting and having an oblong rectangular or oval horizontal section. (Raymond)

Rash. An impure and unmerchantable coal; coal mixed with clay, slate, or other foreign substance taken from the top or bottom of the seam. (St. Louis Union Trust Co. *v.* Galloway, 193 Fed. Rept., p. 106)

Rashing. Soft scaly slate or earth beneath a coal seam, often containing much carbonaceous matter. (Steel). *See* Rash.

Rashings. *See* Wild coal.

Rasp. 1. An instrument used at oil wells for reducing size of box or collar on lost tools in preparation for the use of fishing tools. (Mitzakis)
2. A kind of coarse file. (Webster)

Raspa (Mex.). 1. That portion of the precious metal obtained by scraping the *arrastre* or the *patio* (Egleston).
2. A coarse file or rasp. (Halse)

Raspadura (Mex.). Scrapings. *See* Raspa, 1. (Egleston)

Raspando. Scraping; removing the amalgam from the arrastre by scraping. (Egleston)

Raspar (Mex.). To clean up an arrastre. (Dwight)

Rasposo (Jalisco, Mex.). Ore containing native silver. (Halse)

Rastrillo (Mex.). Rake; stirrer for moving ore in a furnace; a rabble. (Dwight)

Rastrón (Mex.). A Chilean mill. (Dwight)

Rata (Mex.). A candle boy. (Dwight)

Ratch (Prov. Eng.). A subsoil of stone and gravel mixed with clay (Standard). *See* Ratchel.

Ratchel (Eng.). Stone in small fragments or gravel; *also* gravelly subsoil (Webster). Also spelled Ratchell, Rachel, Rachen, Rachill.

Ratches (Lanc.). Lifts of 5 yards in length along a working face. (Gresley)

Ratchet drill. A hand drill in which a lever carrying at one end a drill holder is revolved by a ratchet wheel and pawl (Webster). A drill used for boring slate.

Rate. *See* Rait.

Ratholite. Same as Pectolite.

Ratio of absorption. The percentage by weight that the absorbed water bears to the dry weight of the stone. (Bowles)

Rato (Mex.). An ancient method of mining or burrowing. (Halse)

Rattle (Leic.). To work with great vigor and energy, especially in driving or shaft sinking. (Gresley)

Rattlehead (Scot.). A suction pipe. (Barrowman)

Rattle jack (Mid.). Carbonaceous shale; *also* Hoo cannel. (Gresley)

Rattler. 1. (York.) Cannel coal. (Gresley)
2. (Scot.) Inferior gas coal; sandy shale. (Barrowman)
3. A device for shaking out the cores from small castings, as a tumbling barrel. (Webster)

Rattles (Dev.). *See* Scree, 1.

Raveling. Pulling material out of the ladle furnace, or iron trough at the tap hole of a blast furnace. (Willcox)

Raw. 1. Not prepared for use by heat. (Webster)
2. In ceramics, fresh from a plastic process; unbaked. (Standard)

Raw ore. Ore that is not roasted or calcined. (C. and M. M. P.)

Raw quartz. Quartz that has undergone no treatment, such as burning or reduction, prior to being placed under the stamp heads. (Duryee)

Raya (Mex.). 1. Day's pay. 2. The time worked by miners. (Halse)

Rayado (Mex.). 1. A gold-bearing greasy quartz with iron stains in the form of bands, veins, and zones. 2. A day laborer. (Halse)

Rayador (Mex.) Timekeeper. (Dwight)

Rayar (Mex.). To pay off. (Dwight)

Rayarse (Mex.). To register after work (done) in the mine. (Dwight)

Raywork. A kind of rubble work; in the United States, any rubble work of thin and small stones. (Webster)

Razor back. A sharp narrow ridge. (Webster)

Razor saw. A narrow saw used in excavating limestone. (Webster)

Razor stone. *See* Novaculite.

Reacher. A slim mine-prop reaching from one wall to the other. (Ihlseng)

Reaction. The action of one chemical substance upon another accompanied by the formation of a new substance.

Reaction process. *See* Roasting and reaction process. (Raymond)

Reaction-rims. A term mostly used in microscopic work, for the curious rims of hypersthene, garnet, hornblende, biotite, magnetite, and perhaps other minerals, that surround grains of magnetite or of ferromagnesian silicates, wherever, as in many gabbros, they come next to feldspar. They are supposed to be produced by the reaction of these minerals on each other, probably in the crystallization of the rock. (Kemp)

Reagent. Any substance which, by reason of its capacity for taking part in certain reactions, is used in detecting, examining, or measuring other substances, in preparing material, etc. (Webster)

Real (Sp.). 1. A Mexican mining camp. 2. Royal. 3. A Spanish coin. 4. *R. hacienda*, royal treasury. 5. *R. de minas*, a town having mines in its vicinity. (Dwight)

Realgar. Arsenic monosulphide, AsS. Contains 70.1 per cent elemental arsenic. (U. S. Geol. Surv.)

Realito (Sp.). A small mining center. (Lucas)

Reamer. 1. A tool for enlarging a bore-hole. (Raymond)
2. A kind of chisel for cutting two V-shaped grooves from a round blast-hole in the line of the desired rift (Webster). *See* Reaming, 2.

Reaming. 1. Enlarging the diameter of a bore hole. (C. and M. M. P.) 2. A quarryman's term for the process of cutting grooves on opposite sides of drill holes in order to promote straight splitting of a stone (Bowles). *See also* Reamer, 2.

Rearer (No. Staff.). *See* Edge coal.

Rearer method of working inclined seams. *See* Bord-and-pillar method.

Reata (Mex.). Light rope. (Dwight)

Réaumur. Designating the Réaumur thermometer scale where 0° is the freezing point of water and 80° the boiling point. To convert Réaumur to Centigrade, multiply the former by 1.25. To convert Réaumur to Fahrenheit, multiply the former by 2.25 and add 32°. (C. and M. M. P.)

Réaumur porcelain. A devitrified glass, made in 1739 by Réaumur in St. Cloud, of the nature of artificial soft porcelain. (Standard)

Rebajo (Sp.). 1. Working out or mining ore deposits; *R. del cielo*, overhand stoping. 2. Underhand stoping; *R. lateral*, stoping wide veins. 3. *Rebaje*. (Mex.) A winze or staple. (Halse)

Rebosadero (Sp.). 1. An outcrop; the crest of a lode. 2. An irregular deposit or pocket. 3. (Peru) A gold placer. (Halse)

Rebosador (Peru). River gold-placers. (Dwight)

Rebotalleros (Sp.). Persons who search for ore in waste heaps or waste dumps. (Rockwell)

Recalescence. A glowing again; specifically, in physics, a phenomenon peculiar to heated iron or steel of glowing more brightly when certain temperatures are reached in the process of gradual cooling from a state of high incandescence; supposed to be due to a change of molecular structure. At such temperatures magnetic and other properties of the iron also suddenly change. (Standard)

Recarburize. To carburize again; specifically, to restore to (steel) after decarburization. Called also Recarbonize. (Standard)

Recast. To form anew by running, as molten metal, into a mold; cast again; as, to *recast* a cracked bell. (Standard)

Receiving clack (Scot.). The bottom clack or valve in a pump set. (Barrowman)

Receiving rods (Eng.). Auxiliary cage guides at inpets and at head frames. (Gresley)

Recemented glacier. A glacier formed by recompacted ice which has fallen down a cliff from a higher glacier. (Century)

Recent. The later of the two geologic epochs comprised in the Quarternary period, in the classification generally used; same as Holocene. Also the deposits formed during that epoch. (The Holocene, or Recent, comprises all geologic time and deposits from the close of the Pleistocene or Glacial epoch until and including the present.) (La Forge)

Recepción (Sp.). A plat. (Lucas)

Recession. Going back; leaving part of the sea margin exposed as land (Lowe)

Rechaze (Colom.). A deviation of a lode due to a fault. (Halse)

Reck (Lanc.). Chips of wood and other débris hoisted with coal. (Gresley)

Reckoning day (Eng.). The day on which the workmen receive a statement of wages due, usually two days before pay day. (G. C. Greenwell)

Reclamation. The recovery of coal or ore from a mine, or part of a mine, that has been abandoned because of fire, water, or other cause.

Recodo (Sp.). Refuge hole. (Lucas)

Recoger (Mex.). To collect (Dwight). To pick ore. (Halse)

Reconcentrados (Mex.). Concentrates. (Halse)

Reconnaissance. 1. A preliminary examination or survey of a region in reference to its general geological characters. 2. An examination of a region as to its general natural features, preparatory to triangulation, etc. (Webster)

Reconnoiter. To examine by the eye; survey; especially, to make a preliminary examination of for military, surveying, or geological purposes. (Standard)

Reconocer (Sp.). To search for minerals; to prospect; to costean. (Halse)

Reconocimiento (Sp.). 1. Exploring; prospecting. 2. A survey; an inspection. 3. (Mex.). In the *patio* process, verifying the results obtained. (Halse)

Reconstructed turquoise. An imitation turquoise made of finely powdered ivory which is deposited in a solution of copper. (Century)

Record. To enter in the book of the proper officer (usually a district or county officer) the name, position, description, and date of a mining claim or location. *See* District. (Raymond)

Recorte. 1. (Sp.). Dressing the sides of a shaft. 2. (Colom.). Blankets after being washed on an inclined table, before going to the *arrastre*. (Halse)

Recover. 1. To restore a mine or a part of a mine that has been damaged by explosion, fire, water, or other cause to a working condition. 2. *See* Recovery, 1.

Recovery. 1. The proportion or percentage of coal or ore mined from the original seam or deposit. 2. A general term to designate the valuable constituents of an ore which are obtained by metallurgical treatment; as, the *recovery* was 90 per cent. Recovery is better used in connection with milling operations, while extraction is especially applicable to smelting or wet chemical methods and applies to the bullion actually obtained. "The copper, for example, in a 2 per cent ore is 'recovered' in a 85 per cent concentrate, but it is 'extracted' in a 98 per cent blister because this last is marketable as metal. The gold in a mill is 'recovered' in the cyanide solution, but it is not 'extracted' until precipitated in the zinc-box. Like the amalgam in a stamp-mill, the precipitate in a cyanide-plant is a product so concentrated and so valuable as to be marketable." (Min. and Sci. Press, July 19, 1919, p. 84.) 3. The work of reopening a mine after a disastrous fire or explosion. *See* Rescue, Recover and Reclamation.

Recovery oven. A by-product coke oven. (Webster)

Rectificación (Sp.). The rectification or correction of a mining claim. (Halse)

Rectorite. A pearly-white hydrated aluminum silicate, similar to kaolinite. (Standard)

Recuesto (Sp.). 1. Slope; declivity. 2. Dip or inclination of a vein. (Halse)

Recuperative furnace. A furnace for the recuperation or recovery of heat from the waste gases of combustion. (Ingalls, p. 856)

Red. 1. (Sp.) A net; *R. de vetas*, a network of veins; a stockwork. (Halse)
2. (Prov. Eng.) The waste in coal mining; attle (Standard). *See* Redd, 3.

Red antimony. *See* Kermesite.

Red arsenic. A synonym for Realgar. (Chester)

Red-ash coal. Coal that leaves a reddish ash. (Chance)

Red bole. Same as Red ocher. (Standard)

Red chalk. Red ocher mixed with more or less clay. (Dana)

Red cobalt. An early name for erythrite. (Chester)

Red copper ore. Cuprite. (Power)

Red cross explosives. A class of high explosives characterized by the low-freezing point. (Du Pont)

Redd (Scot.). 1. To scour through, take down, or to rip. 2. To clear out pillars of coal. 3. Pit rubbish or débris. *See* Red, 2. (Gresley)

Redd bing (Scot.). A spoil heap on the surface. (Gresley)

Reddingite. A hydrous phosphate of iron and manganese resembling scorodite in form. From Redding, Connecticut. (Century)

Reddle. A variety of ocherous red iron ore used for marking, especially sheep; red ocher. Called also Red chalk (Standard). Also spelled Ruddle; Raddle.

Reddleman. A dealer in reddle or red chalk. (Century)

Reddsman (Scot.). One who works at night cleaning up and repairing roadways, etc. (Gresley)

Redevance (Fr.). A tax, duty, or rent. In mining law, a tax or duty payable to the Government or to the surface owner. (Raymond)

Red hematite. A compact columnar variety of hematite with a brownish-red to iron-black color. So called to contrast it with limonite and turgite. (Dana)

Redingtonite. A hydrous-chromium sulphate, occurring in fibrous masses having a pale-purple color. (Century)

Rédito (Mex.). Interest. (Dwight)

Red iron froth. A variety of hematite. (Power)

Red iron ore. *See* Hematite.

Red iron vitriol. Same as Botryogen. (Standard)

Red lead. Minium, Pb_3O_4 (Dana).

Red lead ore. Same as Crocoite. (Dana)

Red manganese; Red manganese ore. A term applied to both rhodonite and rhodochrosite, by reason of the reddish color of these two minerals.

Red marl. A term often applied to the New Red Sandstone. (Comstock)

Red measures (Eng.). Generally refers to the strata of Permian or Triassic age. (Gresley)

Red Metal. 1. A copper matte containing about 48 per cent copper. (Webster)
2. Any one of several alloys used in the manufacture of silverware. (Standard)

Red ocher. A red, earthy, and often impure, variety of hematite, used as a pigment (Webster). *See also* Ocher.

Red orpiment. Same as Realgar. (Standard)

Red oxide of zinc. *See* Zincite.

Red phosphorus. Same as Amorphous phosphorus.

Red rab (Corn.). Red killas, or slaty rock. (Power)

Redruthite (Corn.). Copper glance; same as Chalcocite. (Century)

Redsear. In iron-working, to break or crack when red-hot, as iron under the hammer. (Standard)

Red schorl. An old synonym for Rutile. (Chester)

Red-short. Brittle at red heat. *Compare* Cold-short. (Raymond)

Red-shortness. In metallurgy, the quality or state of being red-short. (Century)

Red silver ore. 1. Pyrargyrite: dark-red silver ore. 2. Proustite: light-red silver ore; ruby silver ore. (Dana)

Redstone. A trade name for a red sandstone. (Bowles)

Reduce. 1. To deprive of oxygen. 2. In general, to treat metallurgically for the production of metal. (Raymond)

Reduced fuel oil. Fuel oil of heavy gravity. One having a gravity of 23° Bé. (7.62 lb. per gallon) has been found to contain 19,800 B. t. u. per pound. (Bacon)

Reduced iron. Metallic iron in a fine state of division obtained by reducing ferric oxide by heating it in a current of hydrogen. Called also Iron by hydrogen, Iron-powder, Spongy iron. (Standard)

Reduced oil. Crude petroleum from which the more volatile hydrocarbons have been eliminated by partial evaporation. (Bacon)

Reducing flame. The inner cone of the blow-pipe flame, characterized by the excess of carbon or hydrocarbons of the gas, which at the high temperature present tends to combine with the oxygen of a (the) mineral brought into it. (Dana)

Reducing furnace. A furnace in which ores are reduced from oxides, or metal is separated from other substances by a non-oxidizing heat or flame; usually a shaft furnace. (Century)

Reducing scale. A form of scale used by surveyors to reduce chains and links to acres and rods by inspection, and also in mapping and drawing to different scales. (Century)

Reduction. 1. The act of removing oxygen. (George)
2. The process of separating metals from their ores. (Skinner)

Reduction furnace. A furnace for reducing ores. *See* Reducing furnace.

Reduction works. Works for reducing metals from their ores, as a Smelting works, Cyanide plant, etc.

Red vitriol. Bieberite, $CoSO_4+7H_2O$ (Power). *See* Rose vitriol.

Redwood-Baringer water finder. An instrument designed to ascertain the presence and quantity of water in a tank containing oil. (Mitzakis)

Red zinc ore. A synonym for Zincite. (Chester)

Reed. 1. (Eng.) A grass or other vegetal tube used for a train of gunpowder (fuse) in blasting (Bainbridge). *See* Spire, 1.
2. A weakness in a sedimentary rock parallel with the bedding (Bowles) *See also* Cleat, 1.

Reeder. A frame of thatched reeds used to protect china clay from rain while drying. (Standard)

Reedy coal. Coal having alternate layers of splint and bright coal. (Power)

Reef. 1. (Aust.). A lode or vein. A word introduced into mining by sailors who left their ships to participate in the rush to Ballarat and Bendigo, in 1851. To them a rock projecting above the water was a reef, and the term was therefore applied to quartz outcrops on land. 2. (So. Afr.) In the diamond mines, the barren shales, etc., limiting like an oval funnel, the soft diamantiferous breccia.

Reef drive (Aust.). A cutting through the bed rock in alluvial mining for the purpose of seeking other underground, gold-bearing gravel channels. (Davies)

Reefer (Aust.). A miner who works on a reef. (Webster)

Reefing. Working auriferous reefs or veins. (Lock)

Reef wash (Aust.). Gold-bearing drift. (Skinner)

Reel. 1. (Scot.). A drum or frame on which winding or haulage ropes are coiled. (Barrowman)
2. In blasting, a device for winding the leading wire for avoiding kinking and breaking the wire, and keeping it in good condition. (Du Pont)

Reenforcing; Reinforcing bars. Iron or steel bars of various cross-sectional shapes used to strengthen concrete.

Reese River process. Pan amalgamation with previous roasting. (Liddell)

Reeve (Can.). A foreman in a coal mine. (Standard)

Refacción (Sp.). Repair of a mill or building; *Pieza de R.*, a repair place. (Halse)

Refaccionero (Mex.). The helper of a rock drill operative. (Dwight)

Refikite. A white, very soft resin, $C_{20}H_{16}O_3$, found in the lignite of Montorio, near Feramo, Abruzzes, Italy. (Bacon)

Refine. 1. To free from impurities; to free from dross or alloy: to purify, as metals; to cleanse. 2. To treat cast-iron in the refinery furnace so as to remove the silicon. (Webster)

Refinery. A building and apparatus for refining, or purifying metals, oils, etc. In iron manufacturing, a form of furnace with a shallow hearth for refining cast iron to wrought iron or to iron suitable for puddling. (Webster). *See also* Run-out fire, and Electrolytic process.

Refining. 1. The purification of crude metallic products, as the refining of base bullion (silver-lead) produces nearly pure lead and silver. 2. The conversion of gray into white cast-iron in a run-out fire. (Raymond)

Refining heat. A medium orange heat, about 655° C which imparts fineness of grain and toughness to steel that is raised to it and afterwards quenched. (Webster)

Reflection goniometer. In mineralogy, an instrument for measuring angles.

Reflet. 1. (Fr.) Iridescent glaze; especially the metallic glaze in pottery. 2. Pottery having metallic or iridescent luster; especially a brilliant tinted tile. (Standard)

Reflection wave; Reflexion wave. A wave that is propagated backward through the burned gas as the result of an explosion wave being completely or partly arrested against the closed extremity, or in a constricted portion of its path, as in a tube, gallery, etc. (Mellor, Chemical Statics and Dynamics, p. 490. 1909)

Reflux valve. In hydraulics, a flap valve used for the purpose of taking off the pressure of a head of water acting in a backward direction against a set of pumps (Nat. Tube Co.). A check valve.

Refogar (Peru). To retort amalgam; to distill sulphur from sulphides. (Halse)

Refraction. 1. A change of direction when a ray of light passes from one medium to another of different density. (Power)
2. (Eng.) The percentage of inpurity in a sample of mineral salt; used principally in the saltpeter trade. (Standard)

Refractometer. An instrument for determining the index of refraction of a mineral.

Refractory. 1. Resisting the action of heat and chemical reagents; a quality undesirable in ores but desirable in furnace linings, etc. (Raymond) 2. A piece of pottery ware covered with a vaporable flux and placed in a kiln to form a glaze on other articles. (Webster)

Refuge hole. A place formed in the side of an underground haulage way in which a man can take refuge during the passing of a train, or when shots are fired (Steel). Also called Refuge stalls.

Rega (Braz.). A water conduit or launder. (Halse)

Regadura (Sp.). 1. In coal mining, undercutting, undermining, holing. 2. Undercut. (Halse)

Regalo (Mex.). A bonus to miners. (Lucas)

Regenerative furnace. A furnace for the recuperation or recovery of heat from the waste gases of combustion (Ingalls, p. 356) *See also* Regenerator.

Regenerator. A chamber, filled with open-work of brick, to take up the heat of the gases of combustion from a furnace and subsequently impart it to a current of air, the air and gas being conducted alternately through the chamber. *See* Siemens furnace. (Raymond)

Régime. In hydraulics, the condition of a river with respect to the rate of its flow as measured by the volume of water passing different cross sections at a given time. (Webster)

Regional. Extending over large areas in contradistinction to local or restricted areas. (Sloan)

Regional-metamorphism. Daubree's name for that extended metamorphism that, as contrasted with contact effects, is manifested over large areas. (Kemp)

Registrar (Sp.). To register a title to a mine. (Halse)

Registro (Sp.). 1. A register; an official entry or registration of the possession of a mine. 2. A valve; a damper. (Halse)

Reglamento (Sp.). A regulation; an ordinance. (Halse)

Regola (Sp.). In coal mining, an undercut. (Halse)

Regolith. The layer or mantle of loose, incoherent rock material, of whatever origin, that nearly everywhere forms the surface of the land and rests on the hard or "bed" rocks. It comprises rock waste of all sorts, volcanic ash, glacial drift, alluvium, wind-blown deposits, vegetal accumulations, and soils. (La Forge)

Regradation. The process of forming a new gradation level of equilibrium in a land surface by streams when an old one has become deformed. (Standard)

Regular (Mex.). Average ore; ore of fair grade. (Halse)

Regular-lay rope. A rope in which the wires in each strand are twisted in opposite direction to the strands in the rope. (C. M. P.)

Regulator. 1. A door in the mine, the opening or closing of which regulates the supply of ventilation to a district (Gresley). Usually a slide door.
2. The shutter of a fan. (Barrowman)

Regule (Fr.). A copper regulus from which most of the impurities have been removed by liquation. (Raymond)

Regulus. 1. The metallic mass that sinks to the bottom of a furnace or crucible, separating itself by gravity from the supernatant slag. 2. An intermediate product obtained in smelting ores, especially those of copper, lead, silver, and nickel, and consisting chiefly of metallic sulphides. In this sense it is synonymous with matte, or the German *stein*. Antimony *regulus* is metallic antimony. (Raymond)

Regur (Hind.). A residual, dark-colored, loamy soil of the volcanic regions of India, rich in organic matter, that is not derived from forest growth; similar to the black earth of Russia. Spelled also Regar. (Standard)

Reh (Hind). A sterilizing saltine efflorescence that forms on the surface of parts of the Valley of the Ganges from the evaporation of water rising from beneath. (Standard)

Reheater. An apparatus for reheating a substance, as ingot steel, that has cooled or partly cooled during some process. (Standard)

Reheating furnace. A reverberatory furnace in which the puddled bars, piled in packets, are reheated preparatory to rolling. (Century)

Reinite. Ferrous tungstate, $FeWO_4$. In blackish-brown tetragonal pyramids, perhaps pseudomorphous. (Dana)

Reja (Sp.). 1. A grating. A stamp-battery screen; a grizzly; *R. móvil*, a shaking screen. 2. A grate in a furnace. (Halse)

Rejilla (Sp.). 1. A jig sieve. 2. A furnace grate. (Halse)

Rejuvenation. 1. To render young again. 2. To stimulate, as by uplift, to renew erosive activity; said of streams. 3. To develop youthful features of topography in an area previously worn down to a base level. (Webster)

Relajar (Mex.). To put new stones in the bed of an *arrastre* (Halse). *See* Arrastre, 1.

Relámpago (Mex.). The brightening of the silver button during cupellation. (Dwight)

Relative humidity. The amount of vapor or water in the air, when expressed, in the form of a percentage, as the ratio of the actual quantity of moisture in the air to the quantity that would saturate it under its actual conditions as to pressure and temperature. (Standard)

Relaves. 1. (Mex.) Residue left in a *batea* from a washing test (Dwight). 2. (Chile) Residues left after the Chilean process of amalgamation (Halse). (Peru) Tailings from amalgamating plants. (Pfordte)

Releces (Colom.). Mineral left behind by former working as being unprofitable. (Halse)

Releje (Peru). Supporting mine workings by timbers. (Halse)

Relevée (Fr.). A certain thickness of coal beds and intervening measures (varying between 88 and 160 yards) in inclined strata, that forms a lift or series of workings being prosecuted to the rise at one time. (Gresley)

Relevo (Sp.). Shift; *R. de la tarde*, afternoon shift; back shift. (Halse)

Reliction. The slow and gradual recession of the water by which the land is left dry. (Shamel, p. 307)

Relief. 1. The character of the surface of a mineral section as observed under the microscope, depending upon its refractive power relative to that of the medium in which it is embedded. 2. The elevations or inequalities of a land surface considered collectively. (Webster)

Relief holes. Bore holes, that are loaded and fired for the purpose of relieving or removing part of the burden of the charges to be fired in the main blast. (Du Pont)

Relief map. A model of an area in which its inequalities of surface are shown in relief. (Webster)

Relieving timbers. Replacing broken timber sets with new ones.

Relighting station. (Aust.). A place underground where safety lamps may be lighted in case they have been extinguished. (Power)

Reliquiæ (L.) In geology, fossil organisms. (Standard)

Reliz (Mex.). Wall of vein; *R. de alto*, hanging wall; *R. del bajo*, foot wall. (Dwight)

Relleno (Sp.). 1. Stowing, filling, packing. 2. Waste, gob, or goaf; *R. de un filón*, vein filling. (Halse)

Remanie. 1. (Fr.) Derived from, or containing fossils of an older formation, as, *remanie* deposits. 2. Recemented, as a glacier formed by the falling of fragments of ice (glacier *remanie*). (Standard)

Remblais. 1. (Fr.) A system of working a very thick coal seam in central France. A horizontal slice is first taken out 6 feet 6 inches in height across the seam, and the space filled up with stone, brought from the surface. A second lift is then extracted, and so on. 2. (Fr.) Synonymous with Longwall. 3. (Fr.) Synonymous with Goaf. (Gresley)

Remingtonite. A hydrated carbonate of cobalt found in Maryland. (Century)

Remisión. 1. (Sp.) Act of sending (Halse)
2. (Mex.) A shipment. (Dwight)

Remolino (Sp.). A bunch or mass of ore. (Davies)

Removido (Sp.). Stirring or rabbling. (Halse)

Rendido (Mex.). A term applied to the *torta* when the amalgamation is concluded. (Egleston)

Rendimento. 1. (Sp.) Yield or product. (Halse)
2. *R. de metal*, ore output. (Dwight)

Rendir. 1. (Mex.) To yield. The complete amalgamation of the silver in a *patio* charge. (Dwight)
2. *R. los humos* (Peru), said of ores completely oxidized by roasting. (Halse)

Rend-rock. A variety of dynamite used in blasting, consisting of nitroglycerin, saltpeter, wood pulp, and paraffin or pitch. (Webster)

Reniform. Kidney-shaped; applied to certain minerals. (Thompson)

Renk. 1. An average or standard distance for putting coal at a stated price. (Webster)
2. (Newc.) The average distance coal is brought by the putters. (Raymond)

Rensselaerite. 1. Wax-like masses of talc. Pseudomorphous after pyroxene. (Moses)
2. E. Emmons's name for a talcose rock from St. Lawrence County, N. Y. (Kemp). Now obsolete.

Repairer. *See* Repair man.

Repair man. A workman whose duty it is to repair tracks, doors, brattices, or to reset timber, etc., under the direction of a foreman (C. and M. M. P.). A repairer.

Repasador. 1. (Mex.) The man who turns over pulp in the *patio*. (Dwight)
2. Also one who mixes the ore by treading in the mercury, or who drives mules in that operation. (Halse)

Repasadora (Mex.). A kind of machine for kneading or treading the *torta*. (Halse)

Repasar (Sp.). To stir the batches of ore, in which *magistral* and quicksilver are mixed, as in the *patio* process. (Halse)

Repaso (Mex.). The act of mixing the *patio* charge by treading it with horses or mules. (Dwight)

Repeated twinning. In crystallography, three or more crystals united according to the same law. (Standard)

Replacement. The process by which one mineral or chemical substance takes the place of some earlier different substance, often preserving its structure or crystalline form. (Farrell)

Replacement vein. A vein in which certain minerals have passed into solution and have been carried away, while other minerals from the solution have been deposited in the place of those removed. The process is called Metasomatic replacement. Also called Substitution vein. (Shamel, p. 152)

Replacing-switch. A device consisting of a united pair of iron plates hinged to shoes fitting over the rails to replace, on the track, derailed railway rolling stock (Century). Also used for mine cars.

Reposadero (Mex.). 1. The bottom of a crucible or pot in an upright smelting furnace. (Dwight) 2. A settling tank used in the *patio* process. 3. A receptacle for molten lead in front of a furnace. 4. The contents of a forehearth. (Halse)

Representation work. Same as assessment work on a mining claim. (U. S. Min. Stat., pp. 233–253)

Repressed brick. Bricks that have been put through a second pressing machine after molding to improve their shape, etc. (Ries)

Repressing-machine. A machine for making pressed bricks or for giving ordinary green bricks a second pressing. (Standard)

Resacatin (Sp. Am.). One who buys small quantities of ore from Indians. (Halse)

Resbalón (Sp.). A vertical lode. (Lucas)

Rescatador (Mex.). An ore buyer. (Dwight)

Rescate (Mex.). 1. The purchase of ores. 2. Purchased ores. (Dwight) 3. Public sale of ores. 4. An ore-buying agency. (Halse)

Rescue. To move live men or dead bodies from a mine after a mine disaster. Sometimes called Recover. The latter applies especially to putting the mine in shape for operation again.

Rescue-apparatus. *See* Mine rescue-apparatus.

Rescue-car. *See* Mine rescue-car.

Rescue-crew. *See* Mine rescue-crew.

Resecos (Mex.). Earthy carbonates of lead (Halse). Dry ores. (Dwight)

Reservas (Sp.). Ore reserves. (Halse)

Reserve. 1. To keep back; to keep in store for future or other use. 2. That which is held back, or in stock. Specifically, known ore bodies that may be worked at some future time, as ore reserves.

Reserved coal (Scot.). Coal not included in, but reserved from lease, as coal under buildings. (Barrowman)

Resguardo (Mex.). A penthouse used at the bottom of a shaft as a protection to men while shaft-sinking. (Halse)

Residual. 1. (*a*) Characteristic of, pertaining to, or consisting of residuum. (*b*) Remaining essentially in place after all but the least soluble constituents have been removed: said of the material eventually resulting from the decomposition of rocks. 2. Standing, as a remnant of a formerly greater mass of rock or area of land, above a surrounding area which has been generally planated: said of some rocks, hills, mountains, mesas, plateaus, and groups of such features. (La Forge)

Residual clay. A clay deposit formed by the decay of rock in place. This type is abundant in the Southern States. (Ries)

Residual deposits. *See* Residual, 1*b*, as Residual gravel, sand, clay, etc.

Residuary. Resulting from local rock decay: said of deposits of disintegration that have not been transported. *See* Residual, 1.

Residue. 1. The solid matter remaining after a liquid has been filtered or evaporated. (Duryee) 2. The waste or final product from a hydrometallurgical plant which, at the time of operation, is valueless as far as metal content is concerned. (Eng. and Min. Jour., vol. 107, p. 317)

Residuo (Sp.). 1. Waste from picking ore; final sludge from tin dressing. 2. Alluvial detritus. (Halse)

Residuum. 1. The residue obtained on the distillation of crude petroleum after the constituents boiling below 620° F. have been removed. 2. The residue left in the still after the distillation of crude oil has been completed, and not the residue from redistilled condensates. Also known as the cokings and tailings. (Bacon) 3. The material eventually resulting from the decomposition of rocks in place and consisting of the nearly

insoluble material left after all the more readily soluble constituents of the rocks have been removed. (La Forge) *See also* Residual 1.

Resin. 1. A term applied to secretions of saps of certain plants or trees. It is an oxidation or polymerization product of the terpenes, and generally contains "resin" acids and esters (Bacon). *See* Kauri gum. 2. A term applied to the solid bitumens. *See* Bitumen. (Bacon)

Resin jack. *See* Rosin jack.

Resinous. Resembling resin, as opal, and some yellow varieties of sphalerite. (Dana)

Resin tiff. A light colored zincblende. (Power)

Resistal. A trade name for a special glass used in the manufacture of goggles.

Resorption. A partial refusing of phenocrysts in a porphyritic rock, followed by recrystallization in modified forms. (Standard)

Resorption border. A border of secondary minerals surrounding an original crystal constituent of a rock, produced by partial resorption and recrystallization. (Standard)

Resorte (Mex.). A spring; a spring buffer for rolls. (Dwight)

Respaldeador (Sp.). A cobbing hammer. (Lucas)

Respaldo (Sp.). Wall of a vein; *R. alto*, hanging wall; *R. bajo*, footwall. (Halse)

Respiradero (Sp.). 1. An air shaft. 2. The snore hole of a pump. 3. A blow hole of a volcano through which gases are emitted. (Halse)

Respirator. A device, as a screen of fine wire or gauze, worn over the mouth or nose, by workmen who are obliged to breathe air containing dust or smoke. (Standard)

Resplendent. Shining with brilliant luster; very bright (Century). Sometimes said of minerals.

Rests. The arrangement at the top and bottom of a shaft, or intermediate levels, for supporting the shaft-cage while changing the tubs or cars (Raymond.) Also called Chairs, Keeps, Catches or Wings.

Resue. To open up a stope, not in the vein but in the wall rock. *See* Resuing.

Resuing. A method of stoping wherein the wall rock on one side of the vein is removed before the ore is broken. Employed on narrow veins, (less than 30 inches) and yields cleaner ore than when wall and ore are broken together (Crane).

Resuscitate. To restore to animation or life; especially to restore from apparent death; revive; revivify; as, to *resuscitate* a drowned person (Standard). In cases of electric shock, axphyxiation from mine gases, etc., to revive by means of artificial respiration.

Retaining wall. A wall built to retain earth behind it. (Duryee)

Retaque (Mex.). Lagging and filling combined. (Halse)

Retenida (Mex.). A pillar in a stope. (Dwight)

Reticulate. To divide or mark so as to resemble or form network. (Webster)

Reticulated masonry. Masonry of small square stones, bricks, or tiles placed diagonally, or occasionally of blocks of diamond shape. Called also Reticulated work. (Standard)

Reticulated veins. Veins that cross each other, forming a network. (Power)

Retinalite. A resinous, variety of massive serpentine. (Dana)

Retinellite. A light brown, resinoid substance separated by alcohol from retinasphalt; it begins to fuse at 121° C. (Bacon)

Retinite. The current name, among the French, for pitchstone. (Kemp)

Retirado (Sp.). Working homewards; retreating. (Halse)

Retonation wave. A wave propagated backwards through the burned gases from the starting point of an explosion wave, as of an explosion of gas. (Mellor, Chemical Statics and Dynamics, p. 490. 1909)

Retort. 1. A vessel with a long neck, used for distilling the quicksilver from amalgam. *See* Amalgam retort. 2. The vessel used in distilling zinc. (C. and M. M. P.) 3. To treat by heating in a retort, as gold amalgam, to drive off the mercury and recover the gold. (Webster)

Retorta (Mex.). Retort. (Dwight)

Retort-house. The building containing the gas-retorts in which gas is manufactured. (Standard)

Retorting. 1. Removing the mercury from an amalgam by volatilizing it in an iron retort, conducting it away, and condensing it. (Raymond)
2. In the sulphur industry, synonymous with sublimation, which *see*.

Retort oven. A coke oven that conserves the gas evolved. (C. and M. M. P.)

Retort scaler. An implement for scraping clean the insides of gas retorts. (Standard)

Retreat. To treat over again. Said of tailings from ore-dressing plants.

Retreatal moraine. A moraine deposited during the retreat of the last Pleistocene ice-sheet. (Standard)

Retreating system. 1. A system of robbing pillars in which the line of pillars being robbed retreats or moves from the boundary toward the shaft or mouth of the mine.
2. In longwall mining the system in which all passages are driven to the boundaries and the working face retreats toward the shaft or mouth of the mine. *See* Longwall method.

Return. 1. The air course along which the vitiated air of a mine is returned or conducted back to the upcast shaft. (Steel)
2. The rate of yield of product in any given process of the production per unit of cost, especially in an industrial process. (Webster)

Return air. The air or ventilation that has passed through the workings. (Gresley)

Return aircourse; Return airway. *See* Return, 1.

Return tunnel (Aust.). A tunnel or adit used as a return airway. (Power)

Reussin. An impure Glauber's salt (mirabilite), found native. (Standard)

Reussinite. A resin-like, reddish-brown oxygenated hydrocarbon, soluble in boiling alcohol and in ether (Bacon). Found in certain coal deposits.

Reventazón (Lower Cal., Mex.). Outcroppings. (Lucas)

Reverberar (Mex.). To roast. (Dwight)

Reverberate. 1. To deflect flame or heat, as in a reverberatory furnace.
2. To reduce by reverberated heat; to fuse. (Century)

Reverberatory furnace. A furnace in which ore is submitted to the action of flame without contact with the fuel. The flame enters from the side or end, passes upward over a low wall or bridge, strikes the roof (arch) of the furnace, and is reverberated downward upon the charge. (Raymond)

Reverse bearing. In surveying, a sight taken backward for the purpose of verifying the foresight (Standard). *See* Backsight, 2 and 3.

Reversed stream. *See* Obsequent stream,

Reverse fault. *See* Fault.

Reversing machine. A molding machine having a flask or flasks that may be turned over for ramming the sand. (Standard)

Reversing rolls. *See* Three-high train.

Revestimiento (Sp.). A casing, lining, or covering used in mines. (Halse)

Revet. To face, as with slabs of stone or with any kind of masonry; furnish with a revetment, as to *revet* an embankment, wall, or building. (Standard)

Revet crag. In geology, one of a series of narrow, pointed outliers of eroded strata, inclining inwardly, like a revetment against a mountain. (Standard)

Revetment. A facing, sheathing, or retaining wall, as of masonry or other materials, for protecting a mass or bank of earth, etc., as in fortifications and river banks. (Standard)

Revierbeamt (Ger.). The chief inspector of a district, who gives actual decisions, subject to appeal, in reference to mining questions, rules, etc. (Gresley)

Reviewing (Eng.). *See* Toller.

Revived. Having had its ability to cut down its bed renewed or augmented through increase of its gradient by deformation of the earth's crust by an uplift or tilt; said of certain streams. (La Forge)

Revoltura (Mex.). 1. The mixing of ore with fluxes. 2. A furnace charge. 3. The frequent stirring of minerals during calcination. (Halse)

Revolving screen. A trommel, for sizing or classifying ore.

Reward claim (Aust.). A prospecting claim; often shortened to *reward*. (Webster) A mining claim granted to the discoverer of a mineral-bearing district.

Rezagado (Mex.). Piled up. (Dwight)

Rezago (Mex.). 1. Waste rock. (Dwight)
2. Ore left in a mine. (Halse)

Rezilite mastic. A preparation of elaterite containing asbestos fiber; it is used for surfacing floors. (Bacon)

Rhabdomancy. Alleged divination by rod or wand when searching for minerals. (Power)

Rhaetic beds. Certain fossiliferous shales and limestones of the Upper Trias of Europe and elsewhere. Called also Avicula-contorta zone. (Standard)

Rhaetizite. A white variety of cyanite found in Tyrol. (Dana)

Rhenania furnace. A combination of the Hasenclever and O'Harra furnaces, with four hearths, and with a combination flue under the lowest hearth and one over the upper hearth. Has mechanical rabbles. (Ingalls, p. 156)

Rhenish furnace. A zinc distillation furnace which is a modified type of the Silesian furnace. (Ingalls, p. 413)

Rheostat. 1. An instrument for inserting varying resistance in an electric circuit for controlling the intensity of an electric current. 2. An instrument for testing blasting machines by inserting definite resistance equal to a known number of electric blasting caps of a standard length wire, using one electric blasting-cap as an indicator. (DuPont)

Rhigolene. The most volatile liquid fraction obtained in the distillation of petroleum. It has a boiling point of 18° C. and consists largely of pentane; its specific gravity is 0.60. (Bacon)

Rhinestone. A colorless gem-stone made of paste or strass, and cut, usually as a brilliant, to imitate the diamond. (Standard)

Rhodite. Same as Rhodium gold. (Standard)

Rhodium. A rare element of the light platinum group found in platinum ores and separated as a grayish white metal; insoluble in acids and very difficult to fuse. Symbol, Rh; atomic weight, 102.9; specific gravity, 12.2. (Webster)

Rhodium gold. A native alloy containing from 34 to 43 per cent of rhodium and from 57 to 66 per cent of gold. Called also Rhodite. (Standard)

Rhodochrosite. Manganese carbonate, $MnCO_3$. (U. S. Geol. Surv.)

Rhodolite. A variety of garnet characterized by its roselike color and brilliant luster. Composition corresponds to 2 molecules of pyrope and 1 of almandite. (U. S. Geol. Surv.)

Rhodonite. Manganese silicate, $MnSiO_3$ (U. S. Geol. Surv.). Also called Manganese spar.

Rholites. A word employed by M. H. Wadsworth to designate smelting materials or fluxes. (Power)

Rhomben-porphyries. A name applied to certain Norwegian porphyries, whose phenocrysts of orthoclase resemble a rhombohedron. The orthoclase is rich in soda. (Kemp)

Rhombic dodecahedron. In the isometric system, the ordinary dodecahedron, formed by twelve faces, each parallel to one axis and having equal intercepts on the other two. (La Forge)

Rhombic mica. A synonym for Phlogopite. (Chester)

Rhombic quartz. An old name for Feldspar. (Chester)

Rhombic system. In crystallography, same as orthombic system. (A. F. Rogers)

Rhombohedral. 1. Of, pertaining to, forming, or crystallizing in rhombohedrons. 2. Pertaining to, or belonging in, that group of the hexagonal system which is characterized by a vertical axis of three-fold symmetry and three horizontal axes of two-fold symmetry. (La Forge)

Rhombohedral system. 1. The same as the hexagonal system, except that the forms are referred to three axes parallel to the faces of the fundamental rhombohedron instead of to the usual four axes. 2. The trigonal division of the hexagonal system, the forms being referred to the same three axes as above. (Neither usage has been generally accepted.) (La Forge))

Rhombohedron. A crystal form bounded by six faces of rhombic outline. (Perkins)

Rhomb-spar. A synonym for Dolomite. (Chester)

Rhone. 1. (Scot.) A wooden channel for conveying water. 2. (Scot.) A line of wooden boxes for conveying air. (Barrowman)

Rhums (Scot.). Bituminous shale. (Barrowman)

Rhyacolite. A variety of orthoclase occurring in glassy crystals in lava (Webster). *See* Sanidine.

Rhyolite. A felsophyric to vitreous igneous rock composed essentially of quartz and alkalic feldspar, or of rock glass having substantially the same composition, with or without biotite, hornblende, or pyroxene; liparite. (La Forge) Rhyolite is current in America, whereas liparite and quartz-trachyte are more used abroad. The name was given in 1860 by v. Richthofen (Kemp). A lava, usually of light color, corresponding in chemical composition to granite. The same molten liquid that at great depth within the earth solidifies as granite would, if it flowed out on the surface, cool more quickly and crystallize less completely as rhyolite. (Ransome)

Rib. 1. In coal mining, the solid coal on the side of a gallery or long wall face; a pillar or barrier of coal left for support. 2. The solid ore of a vein; an elongated pillar left to support the hanging-wall, in working out a vein. (Raymond)
3. (Scot.) A thin stratum, as of stone, in a seam of coal. (Barrowman) Also spelled Ribb.
4. A stringer of ore in a lode.

Rib-and-pillar (So. Staff.). A system upon which the "Thick coal" seam was formerly extensively mined, being a kind of pillar-and-stall plan. (Gresley)

Riband stone (Eng.). Sandstone in thin layers alternating in color, generally light and dark gray (Gresley). A variation of Ribbon, 2.

Ribbed. Containing bone (Raymond). Said of coal.

Ribbing. 1. (Lanc.) A strip of coal three yards in width. 2. Enlarging a heading or drift. (Gresley)

Ribbon. 1. A mass of soft or sticky material adhering to a roll during the process of crushing. (Richards, p. 881)
2. Having parallel bands or streaks; as, *ribbon* jasper; in this sense commonly *riband* (Standard). When the lines of contrast are on a larger scale they are said to be *banded*.

Ribbon borer. A boring tool consisting of a twisted flat steel-blade. (Raymond)

Ribbon brake. A friction-brake having a metal strap that encircles a wheel or drum and may be drawn tightly against it (Standard). A band-brake.

Ribbon jasper. *See* Ribbon, 2.

Ribbon rock. *See* Ribbon, 2.

Rib road (Scot.). A road formed along the rib side. (Barrowman)

Rib shot. A shot in the face next to a rib. (Steel)

Rib side (Scot.). The edge of solid mineral left by a longwall working. In longwall working, if one face or wall is considerably in advance of the next it is said to have a ribside. (Barrowman)

Rice coal. A fine size of anthracite. (Webster)

Rice stone. A kind of stone spotted as with rice grains. (Standard)

Richards' pulsator classifier. A classifier operating in such a manner that the pulp grains fall through a sorting column against an upward pulsating current of water. It has no screen. (Liddell)

Richards' pulsator jig. *See* Pulsator jig.

Richards' shallow-pocket hindered-settling classifier. A series of pockets through which successively weaker streams of water are directed upward. The material that can settle does so and is drawn off through spigots. (Liddell)

Ricing (No. Staff.). Lagging. *See* Lacing, 1. (Gresley)

Ricket; Ricketing. 1. (Mid.) A narrow brattice for ventilation. 2. (Mid.) A channel formed along the floor of a mine for drainage purposes. (Gresley)
3. An airway along the side of an adit or shaft. (Morine)

Rick (Penn.). An open heap or pile in which coal is coked. (Raymond)

Rickle (Scot.). A heap or pile, as of stones or peat, loosely thrown together (Century). Same as Rick.

Rico (Mex.). Rich. (Dwight)

Ricolite. A banded variety of verd-antique from New Mexico. (Webster)

Ridar (Corn.). A sieve; a riddle. (Pryce)

Riddam (Eng.). Water, reddish with iron; also scum. (Webster)

Ridding. 1. (No. of Eng.) Separating ironstone from coal shale. (Gresley)
2. Clearing away fallen stone and débris. (C. and M. M. P.)

Ridding pucking (So. Wales). Cutting up or removing a crept floor. (Gresley)

Riddle (Corn. and Scot.). A sieve. The large pieces of ore and rock picked out by hand are called knockings. The riddlings remain on the riddle; the *fell* goes through. (Raymond)

Riddlings. *See* Riddle.

Ride over (Ark.). A squeeze that extends into the workings beyond the pillar. It is said to ride over the pillar. (Steel)

Rider. 1. A thin seam of coal overlying a thicker one. (Steel)
2. The rock lying between two lodes or beds. (Davies)
3. A mass of country rock inclosed in a lode. A horse. (Skinner)
4. A person who rides with the trains of cars, to handle brakes, couple cars, signal, etc., as rope *rider*, trip *rider*. (Steel)
5. (Eng.) A guide-frame for steadying a bucket in a sinking pit. (Gresley)
6. An ore-deposit overlying the principal vein. (Standard)
7. (No. of Eng.) A ferruginous veinstone, or a similar impregnation of the walls adjacent to the vein. (Century)

Ridered. Relating to the country-rock of a vein when impregnated by the vein materials in strings (Standard). *See* Rider, 7.

Ride-the-tow (Scot.). To slip or slide down the shaft rope. (Barrowman) *See* Run-the-tow, 2.

Ridge fillet. A runner or principal channel for molten metal. (Standard)

Ridge roll. A curved piece for covering the ridge of a roof laid with roofing tile. (Ries)

Ridge-T. Used in roof tiling to indicate a trimming piece for use at the intersection of two ridges. (Ries)

Ridge tile. A roofing tile having the upper half flattened to a plane, and used at the roof ridge. It is covered by a finishing tile. (Ries)

Ridgeway filter. A horizontal revolving, continuous vacuum filter. The surface is an annular ring consisting of separate trays with vacuum and compressed air attachments. The filtering surface is on the under side, the trays being dipped into the tank of pulp to form the cake, and then lifted out of it. (Liddell)

Ridging. *See* Cresting.

Riding. Said of mine timbering when the sets are thrust out of line, or lean. (Sanders, p. 156)

Rid up. To clean out rubbish or waste from a mine, metallurgical plant, etc.

Rid-up runners. To clean up after a cast, as when the scrap, slag, and iron is removed from runners, troughs, and skimmers, and they are freshly clayed, loamed, or sanded. (Willcox)

Riego (Sp.). 1. Irrigation. 2. Allaying coal dust by means of a spray. 3. (Colom.) Float ore. (Halse)

Riel (Sp.). 1. A railroad rail. 2. A small bar or ingot of crude gold, silver, or copper. (Halse)

Riffle. 1. From the Danish *rifle*, a groove or channel. In mining, the lining of the bottom of a sluice, made of blocks or slats of wood, or stones, arranged in such a manner that chinks are left between them. The whole arrangement at the bottom of the sluice is usually called *the riffles*. In smaller gold-saving machines, as the cradle, the slats of wood nailed across the bottom are called *riffle-bars*, or simply *riffles* (Century). A groove in the bottom of an inclined trough or sluice, for arresting gold contained in sands or gravels. (Standard)
2. A ripple in a stream or current of water; also a place where the water ripples or is set in violent commotion, as on rocks or shallow rapids. (Webster)
3. A modification of the split shovel, *which see*. (Richards, p. 844)

Riffle-bars. Slats of wood nailed across the bottom of a cradle or other gold-washing machine for the purpose of detaining the gold. (Century)

Riffle-blocks. Cross sections of timber set on the floor of a sluice, with irregular spaces between, in which the gold settles. Also called Riffle-bars. *See* Riffle. (Miller)

Rifled. 1. A drill hole, in rock, that has become three-cornered while drilling. (Gillette, p. 24)
2. Said of a drill-core that has spiral markings.

Rifled pipe. A pipe used for conveying heavy oils. The pipe is rifled with helical grooves which make a complete turn through 360 degrees in about 10 feet of length. (Nat. Tube Co.)

Rifles (Sp. Am.). Riffles. (Lucas)

Rifling (So. Staff.). 1. Working the upper portion of a coal seam over waste or goaf. (Gresley)
2. The spiral grooves appearing on the surface of drill cores.

Rift. 1. An obscure foliation, either vertical (or nearly so) or horizontal, along which a rock splits more readily than in any other direction. *See* Grain, 1. (Watson, p. 462)
2. *See* Fault trace. 3. A shallow rocky place in a stream. (Webster)

Rift valley. A relatively long and narrow trough-like valley formed by the sinking of a strip of the earth's crust between two approximately parallel and opposed normal faults or zones of faulting. (La Forge)

Rig. A derrick, with its engine house, etc., necessary to run it, used for boring, and afterwards pumping, an oil well; also, the derrick itself. (Webster)

Rigger. A semi-skilled employee at blast furnaces, whose duties are largely with construction and repair work, rather than maintenance. Skilled in use of hoist tackle, winches, etc., and usually able to do riveting and to assemble material. (Willcox)

Right-angled block. In quarrying a block of stone bounded by 3 pairs of parallel faces, all adjacent faces meeting at right angles. (Bowles)

Right of way. A grant by Act of Congress, to convey water over or across the public domain, for mining purposes. (U. S. Min. Stat., p. 612)

Right running (No. of Eng.). 1. Applied to a vein carrying ore in beds often unproductive (Bainbridge).
2. Rake veins extending approximately east and west. (Power)

Right-running lode. A lode parallel to the axis of elevation of the district. (Standard)

Rill. 1. The coarse ore at the periphery of a pile. (C. and M. M. P.)
2. A very small brook; a streamlet. (Webster)

Rill-cut stoping. *See* Rill stoping.

Rill-cut vertical stopes. *See* Rill stoping.

Rill marks. Small depressions in sandstone, produced by the eddying of a retreating wave on a sea beach under the lee of some small obstruction, such as a shell or pebble. (Kemp)

Rill stoping. Stoping in which the ore is cut back from the winzes in such a way that an inverted pyramid-shaped room is created, with its apex in a winze and its base at the level. (H. C. Hoover, p. 98)
Sometimes called Pyramidal stoping, Inclined cut and filling, Rill-cut vertical stopes, Overhand stoping in inclined floors, and Rill-cut stoping.

Rim rock. The bedrock rising to form the boundary of a placer or gravel deposit. (Raymond)

Rine pan. A pan in which salt water is evaporated to obtain salt.

Ring. 1. A complete circle of tubbing plates around a circular shaft.
2. Troughs placed in shafts to catch the falling water, and so arranged as to convey it to a certain point. (Steel)
3. (Newc.). A gutter cut around a shaft to catch and conduct away the water. (Raymond)
4. (So. Staff.). A circular piece of wrought-iron, about 8 inches deep, placed on the top of a skip of coal to increase its capacity. (Min. Jour.)

Ring crib (Eng.) A wedging crib upon which tubbing is placed, having a gutter or ring cast round the inner edge, to collect any water that may run down the walls of the shaft. (Gresley)

Ringer. 1. (Derb.) A hammer for driving wedges. (Gresley)
2. A crowbar. (Webster)

Ringer-and-chain (Mid.). *See* Dog and chain, 1.

Ring kiln; Sod kiln. A lime kiln made by digging a conical pit, filling it with alternate layers of limestone and fuel, and covering the top with sods. (Standard)

Ring ore. Fragments of gangue covered with regular deposits of other minerals. *See* Sphere ore. (Power)

Ring pit. A circular pit in which a large wheel is revolved for tempering clay. (Ries)

Ring-small. Designating stones, as for road-making, small enough to pass through a ring of specified diameter. Ring-small stones. (Webster)

Ring stone. A voussoir showing on the face of the wall, so called as helping to make up the arch ring. (Webster)

Ring wall. The inner fire-brick wall of a blast furnace. (Standard)

Riñón (Mex.). 1. A kidney-shaped mass of ore. 2. Reniform tin ore. 3. (Colom.) A place in a mine where ore is abundant. (Halse).

Rio (Sp.). River; stream. (Halse)

Riolita (Sp.). Rhyolite. (Halse)

Rip (Mid.). To cut or blast down the roof or top (Gresley). Also to take up the floor or bottom. (Barrowman)

Riparian rights. The rights of a person owning land containing or bordering on a watercourse or other body of water in or to its banks, bed, or waters. At the common law a person owning land bordering a non-navigable stream owns the bed of the stream and may make reasonable use of its waters. (Webster; also U. S. Min. Stat., p. 619)

Ripiadores (Colom.). Workmen employed to lower ore through a winze. (Halse)

Ripidolite. *See* Clinochlore and Prochlorite.

Ripio (Sp.). 1. Rubble. 2. Ballast material. 3. (Mex.) Fragments of stone placed between the stones forming the bed of an arrastre. 4. Waste; attle; deads. 5. (Colom.) Spalled ore; small ore from the mine. 6. (Chile) Residue obtained by evaporating caliche. (Halse)

Ripper. 1. (Mid.) A man who rips. *See* Rip. (Gresley). 2. A slate-edging tool. (Standard)

Ripping-bed. A machine for cutting stone into slabs; a gang stone-saw. (Standard)

Ripple. A groove or bar across sluices for washing gold (Roy. Com.). *See* Riffle.

Ripple board. An inclined trough having grooves or strips across its bottom to catch fine gold (Duryee). A riffle.

Ripple drift. A rock-structure resulting from the constant deposition of silt, where ripple-marked surfaces are successively formed, and thus covered and preserved (Standard). *See* Ripple mark.

Ripple mark. The wavy surface of some beds of sandstone and mudstones, produced by gentle movement in shallow water when these rocks were in a soft condition. (Roy. Com.)

Rippling. *See* Ripple mark.

Riprap. A foundation or sustaining wall of stones thrown together without order. (Webster)

Risco (Mex.). 1. Sharp, precipitous rock. 2. Quartz found in veins or outcrops. (Dwight)

Rise. 1. To dig or work upward in mining, in opposition to sink. 2. A shaft excavated from below upward (Webster and Standard). The completed excavation is also called a Raise, Upraise, or Riser. *See* Raise. 3. The inclination of the strata, when looking up hill. To the rise is directly up hill in an inclined coal seam. (Steel)

Rise doors (Scot.). The entrance from a shaft into upper workings. (Barrowman)

Rise heading. A heading driven to the rise in long-way workings. *See* Heading, 3. (Raymond)

Rise level (Scot.). The upper of two parallel level roads. (Barrowman)

Riser. 1. A shaft excavated from below upward (Webster). *See* Raise, *also* Rise, 2.
2. (No. of Eng.) An upthrow fault. (Gresley)
3. A passage or channel from the interior of a mold, in which the molten metal rises and by its pressure keeps the mold full as the metal in the latter contracts. 4. In mining, a rising main; *See* Column pipe. (Standard)

Rise split (Eng.). The proportion of the ventilating current sent into the rise workings of a mine. (Gresley)

Rise workings (Eng.). Underground workings carried on the rise or high side of the shafts. (Gresley)

Rising. 1. An excavation carried from below upward; a rise or riser. 2. The boiling in the mold of molten steel after teeming. 3. The honeycombing of a steel casting, caused by such boiling. (Standard)

Rising column (Scot.). Delivery pipes of a ram or plunger pump. (Barrowman)

Rising main. *See* Column pipe.

Rither (Eng.). The matrix in which an ore occurs. *See* Rider, 7. (Bainbridge)

Rittinger table. A side-bump table with plane surface, actuated by a cam, spring, and bumping post. (Liddell)

Rivelaine. A pick with one or two points, formed of flat iron, used to undercut coal by scraping instead of striking. (Raymond)

River-bar placers (Alaska). Placers on gravel flats in or adjacent to the beds of large streams. (U. S. Geol. Surv. Bull. 259, p. 33)

River claim. A claim that includes the bed of a river. (Duryee)

River drift. The gravel deposits accumulated by a river in its torrential stages. (Century)

River marble. *See* Landscape marble.

River mining. Mining or excavating beds of existing rivers after deflecting their course, or by dredging without changing the flow of water.

River pebble. A term applied in Florida to a certain class of phosphatic pebbles, or concretions, found in rivers as distinguished from land pebble phosphates. (Power)

River right. Same as Creek right. (Duryee)

River valley. The depression made by the stream, and by its various processes which precede and accompany the development of the stream. (Webster)

Rives-in (Eng.). To crack open, or produce fissures. (Gresley)

Rivet catcher. An appliance attached to the pump rods of oil wells to prevent damage to the pump from the dropping of rivets from the pump rods. (Mitzakis)

Rivet steel. A soft kind of mild steel, used especially for making rivets. (Webster)

Riving seams. Open fissures between beds of rock in a quarry. (Hitchcock)

Roach (Eng.). 1. The upper and most valuable bed of Portland stone (Standard). 2. A rock; refuse gritty stone.

Roadbed. The material part of a road; primarily, the foundation of gravel, road-metal, etc., constituting the bed, but by extension, especially in railway use, the superstructure also. (Standard)

Road binders. A group of products consisting of petroleum asphalt, properly fluxed with heavy petroleum oils that will not evaporate and of such qualities that they will bind the road materials together both in summer and winter. (Bacon)

Roadhead (Scot.). In long-wall, the end of a road at the working face (Barrowman). *See* Gate end.

Roading (Eng.). Repairing and maintaining roads. (Gresley)

Roadman. A person whose duty it is to keep the roads of a mine in order. (Roy)

Road material. *See* Road metal.

Road metal. Rock suitable for surfacing macadamized roads and for foundations for asphalt and concrete roadways. (U. S. Geol. Surv.)

Roadstones. Stones used for road metal. (Webster)

Roadway (Aust.). An underground passage, whether used for haulage purposes or for men to travel to and from their work. (Power)

Roaring (Cal.). A disease among horses in which there is partial or complete paralysis of certain muscles of the neck and throat, often a result of lead poisoning. (U. S. Bur. Mines, Bull. 98, p. 54)

Roast. To heat to a point somewhat short of fusing, with access of air, as to expel volatile matter or effect oxidation; in copper metallurgy, applied specifically to the final heating which causes self-reduction to occur by the reaction between the sulphide and the oxide. (Webster)

Roaster. 1. A contrivance for roasting, or a furnace for drying salt cake. (Webster)
2. A reverberatory furnace or a muffle used in roasting ore. (Standard)

Roaster slag. Slag resulting from the calcination of the "white metal" in the English process of copper-smelting. (Standard)

Roasting. Calcination, usually with oxidation. Good, dead, or sweet roasting is complete roasting, *i. e.*, carried on until sulphurous and arsenious fumes cease to be given off. Kernel-roasting is a process of treating poor sulphide copper ores, by roasting in lumps, whereby copper (and nickel) are concentrated in the interior of the lumps. (Raymond)

Roasting and reaction process. The treatment of galena in a reverberatory, by first partly roasting at a low temperature, and then partly fusing the charge at a higher temperature, which causes a reaction between the lead-oxide formed by roasting and the remaining sulphide, producing sulphurous acid and metallic lead. (Raymond)

Roasting and reduction process. The treatment of lead ores by roasting to form lead-oxide, and subsequent reducing fusion in a shaft furnace. (Raymond)

Roasting cylinder. A furnace with a rotating cylinder for roasting ore. (Standard). *See* Brückner furnace.

Roasting furnace. A furnace in which ore is roasted.

Roasting kiln. A kiln for roasting ore.

Roasting oven. An oven for roasting ores.

Roast stall. A form of roasting furnace, built in compartments or stalls open in front, with flues running up the wall at the back for the purpose of creating a draft. (Century)

Rob. To extract pillars previously left for support; or, in general, to take out ore or coal from a mine with a view to immediate product, and not to subsequent working. (Raymond)

Robbed out (Cumb.). Work away. *See* Hollows (Gresley). Said of a mine or part of a mine from which the pillars have been removed.

Robbing; Robbing pillars (Scot.). Reducing the size of pillars; taking as much as possible off pillars, leaving only what is deemed sufficient to support the roof. (Barrowman)

Robble (Eng.). A fault. (Gresley)

Robson and Crowder process. An early oil flotation process. The oil was added to several times its weight of ore and mixed in a slowly revolving drum or tube. The process at one time had quite a large application. The process used but little water, 25 per cent to 30 per cent and no acid. (Megraw, p. 14; T. J. Hoover, p. 6)

Roburite. An explosive containing, according to one formula, chlorinated dinitrobenzene and ammonium nitrate. (Webster)

Roca (Sp.). 1. Rock standing out from the general surface. 2. Rock or stone, whether in the ordinary or geological sense. 3. A vein or bed of hard rock and stone. (Halse)

Rocalla (Sp.). Drift of pebbles washed together by floods; talus. (Halse)

Roche. 1. (Prov. Eng.) Refuse gritty stone. 2. A rock. Spelled also Roach. (Standard)

Roche lime (Eng.). Lime in the lump after it is burned; quicklime. (Webster)

Rochelle salts. Potassium-sodium tartrate, $KNaC_4H_4O_6.4H_2O$.

Roches moutonnées. Rounded hummocks or bosses of rock like whales' backs, smoothed and striated by glacial action (Roy. Com.). Called also, Dressed rocks; Sheep-back rocks.

Rochlederite. A resinoid, reddish-brown oxygenated hydrocarbon, found in brown coal in Bohemia; it melts at 100° C. and is soluble in alcohol. (Bacon)

Rock. 1. (*a*) Strictly, any naturally formed aggregate or mass of mineral matter, whether or not coherent, constituting an essential and appreciable part of the earth's crust. (*b*) Ordinarily, any consolidated or coherent and relatively hard, naturally formed mass of mineral matter; stone. (La Forge) In instances a single mineral forms a rock, as calcite, serpentine, kaolin, and a few others, but the vast majority of rocks consist of two or more minerals.

2. (Lake Superior) Crude copper ore as it comes from the mines. The concentrate obtained is called *mineral*, and contains about 65 per cent metallic copper.

3. (N. Y. and Pa.) A local term for the more massive beds of bluestone that are not jointed and are, therefore, well suited for structural purposes. (Bowles)

4. A peak, cliff, promontory, or the like, of rock, usually bare, and considered as one mass, as the Rock of Gibraltar. 5. (Corn.) A big lump of ore. (Webster)

Rock-and-rig (So. Staff.). A sandstone full of little patches and shreds of coal. (Gresley)

Rock asphalt. Sandstone or limestone naturally impregnated with asphalt. (Bacon)

Rock-asphalt pavement. A wearing course composed of broken or pulverized rock-asphalt, with or without the addition of other bituminous materials. (Bacon)

Rock basin. A depression or basin-like excavation in the solid rock, sometimes of great extent. Nearly all lakes, even the largest of them, are entirely surrounded by solid rock or lie in rock basins. (Roy. Com.)

Rock bind (Eng.). Sandy shale. (Gresley)

Rock bottom. In well digging, a stratum of rock preventing further excavation; used generally in a figurative sense, and often attributively; as, a *rock-bottom* price. (Standard)

Rock bound (Aust.). A reef not accompanied by gangue stuff. (C. G. W. Lock)

Rock breaker. Usually applied to a class of machines, of which Blake's rock-breaker is a type, and in which the rock is crushed between two jaws, both movable, or one fixed and one movable. It is common to use a rock-breaker instead of hand-spalling to prepare ore for further crushing in the stamp-mill (Raymond). *See* Rock crusher.

Rock butter. A variety of halotrichite. Called also Stone butter. (Standard)

Rock channeler. A machine used in quarrying for cutting an artificial seam in a mass of stone. It is made in several forms, the principal types being the *bar-channeler* (in which the cutters are mounted on a carriage that works along a heavy bar or bars) and the *track-channeler*. (Standard)

Rock chute *See* Chute, 1. Also called Slate chute.

Rock-chute mining. *See* Bord-and-pillar method.

Rock cork. A light-colored variety of asbestos (Standard). Also called Rock leather.

Rock crusher. A machine for reducing rock or ore to smaller sizes. Three principal types are the jaw-crusher, the gyratory, and the hammer crusher. *See* Rock breaker.

Rock crystal. Transparent quartz, especially when colorless. (Webster)

Rock drill. A machine for boring in rock, either by percussion, effected by reciprocating motion, or abrasion, effected by rotary motion. Compressed air is the usual motive power, but steam, electricity and electricity in combination with compressed air are also used.

The following are common types: *Burleigh.* The first rock drill manufactured in the United States. A term applied by miners to any heavy two-man drill. *Chippy.* A name applied to small piston drills. *Jack hammer.* A name given by the manufacturer to the first self-rotating drill made in the United States. *Murphy.* A hollow steel hand drill; also called *Jap* or *Little Jap.* *Waugh.* A stoping drill; sometimes called a *stoper;* also known in the Southern States as a *warrior.* *Widow-maker.* a name applied to stoping drills by reason of the unhealthy effect of the dust on the miner's lungs. *Wiggle tail.* A name applied to a stoping drill, derived from its actions when in operation. (Eng. & Min. Jour., May 15, 1915, p. 861). *Water Leyner.* A type of drill using hollow steel through which water flows to remove and allay dust. Also called Leyner-Ingersoll drill.

Rocker. A short trough in which auriferous sands are agitated by oscillation, in water, to collect their gold. (Raymond). *See* Cradle, 3.

Rock-face brick. Brick with surface chiseled to imitate cut stone. (Ries)

Rock fault (Eng.). A replacement of a coal seam over a greater or less area, by some other rock, usually sandstone. (Gresley)

Rock filling. 1. Waste rock, used to fill up worked-out stopes to support the roof. (Weed)
2. *See* Overhand stoping.

Rock flour. Very finely powdered rock material, formed by the grinding up of rocks beneath a glacier, deposited as part of the till, and not washed or blown away and deposited elsewhere as stratified drift or as loess. (La Forge) Called also Glacier meal, and Rock meal.

Rock froth. Fused lava so inflated with gas bubbles or steam bubbles as to be foamy. When hardened it becomes *vesicular* or *scoriaceous lava.* (Standard)

Rock gas. Same as Natural gas.

Rock gypsum. Massive gypsum, sometimes crystalline, also microcrystalline or fine grained, as in alabaster. (Webster)

Rockhead. 1. (Scot.) In boring or sinking, the top of hard strata next the surface. (Barrowman) 2. (Ches.) The uppermost stratum of the rocksalt beds. (Gresley)

Rock house (Lake Superior). The building (usually the one over the shaft) where copper-bearing rock from the mine is dumped from the ore skip (or bucket) and is screened, crushed, and stored in a bin, ready for shipment to the mill. (Weed)

Rocking. The process of separating ores by washing on an incline trough. (Lawver) *See also* Rocker.

Rocking bob. *See* Bob, 1.

Rocking lever (Eng.). A brakestaff. (Gresley)

Rocking stone. A stone, often of great size, so balanced on its foundation that it can be rocked, or slightly moved with but little force. In some cases it is left in this position by the weathering away of the softer material (Webster). Called also Loggan stone.

Rock in place. *See* In situ.

Rock leather. A synonym for Mountain leather. (Chester)

Rock meal. 1. A fine flour-like earth composed of shells of infusoria. 2. A white powdery variety of calcite, occurring as an efflorescence (Webster). *See* Rock flour, 2. *Also* Rock milk.

Rock milk. Soft pulverulent forms of calcite found in caves or as an efflorescence. (Power)

Rock oil. A synonym for Petroleum.

Rock pulverizer. A rock breaker; stone crusher. (Standard)

Rock quartz. The ordinary crystallized varieties of quartz, as Brazilian pebbles. Called also Rock crystal. (Standard)

Rock rubble. Same as Fault rock. (Standard)

Rock ruby. A fine red variety of garnet. (Webster)

Rock salt. Common salt occurring in solid form as a mineral; halite. (Webster)

Rockshaft. A shaft made purposely to send down rock for filling the stopes, rooms, or slices. The shaft is generally kept nearly full, and th erock is trammed away as it is wanted. (Standard)

Rock silk. A silky variety of asbestos.

Rock soap. A pitch-black or bluish-black aluminum silicate, greasy to the touch, and which crumbles in water; used as a filler and for crayons. Called also Mountain soap. (Standard)

Rock tar. Crude petroleum. (Standard)

Rock tunnel. A tunnel, drift, or crosscut driven through rock, usually connecting one coal bed with another; also through barren rock in metal mines.

Rock turquoise. A matrix of turquoise with small grains of turquoise embedded in it. (Century)

Rockwood. A brown compact variety of asbestos, resembling fossil wood. (Standard)

Rod coupling. A clasp or other device for uniting the rods that carry the tools used in boring artesian wells, oil wells, etc. (Century)

Rodding (Eng.). The operation of fixing or repairing wooden cage guides in shafts. (Gresley)

Rod guide. An appliance attached to the drilling rod in oil wells that serves to prevent the rod from oscillating or knocking against the sides of the bore hole. (Mitzakis)

Rodillo (Sp.). A wooden roller for moving heavy weights. (Halse)

Rod iron. Iron made in the form of round iron rods for commercial use. (Standard)

Rodman; Rodsman. One who uses or carries a surveyor's leveling rod. (Standard)

Rodney (Eng.). A rude platform near the shaft's mouth for a night fire. (Bainbridge)

Rods. 1. (Eng.) Vertical or inclined timbers for actuating pumps. 2. Long bars of Swedish iron of the toughest quality, for boring through rocks, etc. 3. *See* Cage guides, 1. (Gresley)

Rod shaft. The mine shaft containing the pump rods. (Davies)

Rod tools. *See* Pole tools.

Rod-wax. A light-yellow, pasty mass consisting of an emulsion of high-boiling oils with solid hydrocarbons; it collects in considerable quantities around the rods and casing in some of the Pennsylvania wells. (Bacon)

Roesing lead-pump. An automatic apparatus for discharging lead from the kettle. Used in Parkes' process. (Hofman, p. 480)

Roesing wires. Wires suspended in a dust chamber to assist in settling and condensing dust and fumes from furnace gases. (Hofman, p. 392)

Roesler process. A process for separating copper, and in part silver, from gold by fusing with sulphur or with antimony sulphide, obtaining copper or silver sulphide. (Goesel)

Roe stone. Fine-grained oölite, that resembles the roe of a fish. (Power)

Rogenstein (Ger.). Oölite in which the spherules are united by argillaceous cement. (Standard)

Roggan. A rocking stone. (Century)

Roily oil. Crude oil that has formed a more or less complete emulsion with water. (Redwood)

Rojo (Sp.). Red. (Halse)

Roke (Prov. Eng.). A vein of ore. (Standard). A variation of Rake. *See* Rake 3 and 4.

Roldana (Sp.). A pulley wheel or sheave. (Halse)

Roll. 1. An inequality in the roof or floor of a mine. 2. (So. Wales) The drum of a winding engine. 3. *See* Bump. (Gresley) 4. A cylindrical body set in bearings (usually fixed) and used singly or in pairs or sets for crushing or squeezing (Webster). *See* Rolls. 5. One of two cylinders or grooved rollers between which material is drawn, as for reducing its thickness, as the finishing *rolls* of a rolling mill. 6. A heavy metal cylinder for flattening molten plate glass into a sheet. (Standard)

Rolled plate. A thin plate of gold spread upon a layer of base metal by soldering the metals in the bar, and then rolling the whole out into plate, forming a thinner plate of gold than that of the ware known as gold-filled. Called also Rolled gold. (Standard)

Roller. A small steel, iron, or wooden wheel or cylinder upon which the hauling rope is carried just above the floor. (Steel)

Roller grip. A device for clutching a traction cable between grooved sheaves or rollers. (Standard)

Rolley (No. of Eng.). A kind of truck running upon wheels for carrying tubs or boxes, and drawn by horses along underground roadways. (Gresley)

Rolleyway (No. of Eng.). The underground road along which rolleys are conveyed (Gresley). A gangway.

Rolleyway man (Eng.). A man who attends the rolleyway and keeps it in order. He also supervises the movement of cars at shaft landings. (G. C. Greenwell)

Rolling. *See* Roll train.

Rolling ground. A land surface much varied by many small hills and valleys. (C. and M. M. P.)

Rolling mill. 1. An establishment in which metal is made into sheets, bars, rails, or rods, by working it between pairs of rolls. 2. A pair or set of rolls between which metal is reduced in thickness or formed into beams, rails, etc.; a roll train. (Standard)

Rolling plant. A rolling mill or establishment for rolling metal into forms. (Standard)

Roll-jaw crusher. A crusher of the same general type as the Blake or Dodge (which *see*), but the moving jaw has a rolling instead of an oscillating motion. (Liddell)

Roll latten. Sheet brass polished on both sides. (Standard)

Rolls. Cast-iron cylinders, either plain or fitted with steel teeth, used to break coal and other materials into various sizes (Steel). Applied to the type of crushing machinery in which the ore is broken between cylindrical rolls which rotate in a vertical plane. *See also* Roll train.

Roll scale. The scale that falls from iron during the process of rolling. (Standard)

Roll shell. The casing or tire of specially hardened steel forming the wearing surface of a crusher roll. (Richards, p. 66)

Roll sulphur. A commercial name for sulphur that has been purified and cast into rolls or sticks. (Standard)

Roll train. The set of plain or grooved rolls through which iron or steel piles, ingots, blooms, or billets are passed, to be rolled into various shapes. (Raymond)

Rolo. (Sp.) 1. A roller or drum; *R. de porta cable* (Mex.), the bearing drum of cable tramway. (Dwight)
2. A smooth and round long stone found in *arroyos*. 3. A coil of fuse. (Halse)

Romaneador (Mex.). A weigher. (Dwight)

Romanium. An alloy consisting of aluminum having an admixture of less than 10 per cent of tungsten together with a little copper and nickel. (Webster)

Roman ocher. A native ocher of a deep orange-yellow color. (Standard)

Roman tile; Roman brick. Brick usually either dry-pressed or stiff-mud repressed, and 12 by 1½ by 4 inches in size. The term is not always very definitely used. (Ries)

Roman vitriol. Same as Blue vitriol.

Romanzovite. A variety of garnet, of a brown or brownish-yellow color. (Century)

Romper (Sp.). 1. To break or crush ore. 2. To pierce or penetrate; to break through. (Halse)

Rondana (Mex.). Gasket; washer. (Dwight)

Rondle; Rondelle. The crust or scale that forms upon the surface of molten metal in cooling. (Raymond)

Rongueros (Peru). Men and boys who carry *capachos*. (Halse)

Roof. 1. The rock lying above a coal bed or ore vein. The hanging wall. (Chance)
2. The top of any subterraneous passage or working. (Gresley)
3. (No. Wales). In slate quarrying, a passage excavated from below upwards; a raise. (Webster)

Roof coal (Scot.). That part of a seam of coal left for a roof. (Barrowman)

Roofing. 1. (Ches.) The upper 5 or 6 feet of the rock-salt beds. (Gresley)
2. The wedging of a loaded wagon or horse against the top of an underground passage. (Raymond)

Roofing slate. A finely fissile, compact, homogeneous argillite or clay slate, yielding thin slabs, used for roofing. The prevailing colors are nearly black, though sometimes greenish, purple, or red. (Standard)

Roofing tile. Burned-clay tile used for covering roofs. (Ries)

Roof stone (Scot.). The stone immediately above a coal seam (Barrowman) *See also* Roof, 1.

Roof work. A term applied to a vein worked overhead. (Morine)

Room. 1. A wide working place in a flat mine corresponding to *stope* in a steep vein. *Compare* Stope (Ihlseng). A chamber.
2. A heading or short stall. 3. A weight of 7 tons of coal, or 5½ chaldrons by measure. (Gresley)

Room and pillar. A system of mining in which the distinguishing feature is the winning of 50 per cent or more of the coal or ore in the first working. The coal or ore is mined in rooms separated by narrow ribs or pillars. The coal or ore in the pillars is won by subsequent working, which may be likened to top slicing, in which the roof is caved in successive blocks. The first working in rooms is an advancing and the winning of the rib (pillar) a retreating method. The rooms are driven parallel with one another, and the room faces may be extended parallel, at right angles, or at an angle to the dip. This method is applicable to flat deposits, such as coal, iron ore, lead, and zinc, etc, that occur in bedded deposits. Modifications of this method are: County of Durham system; Double-entry room and pillar mining; Double-room system; Double stall working; Heading and stall; Pillar and stall; Post and stall; Room and stoop; Single-entry room and pillar mining; Single-stall working; Square work; South Staffordshire thick-seam method; Stall and breast; and Triple-entry room and pillar mining.

Room and pillar with waste filling. *See* Overhand stoping.

Room and rance (Scot.). A system of working coal with long narrow pillars; less usually a system of working with extra large pillars and narrow rooms (Barrowman). Similar to pillar and stall.

Room and stoop (Scot.). *See* Room and pillar.

Room neck. A short passageway, from the mine entry, to the room in which the miner works. (Gambino *v.* Manufacturers' Coal & Coke Co., 164 S. W. Rept., p. 265)

Room system with caving. *See* Bord and pillar.

Rooster coal. *See* Cube coal.

Root deposit (Malay). A lode or vein from which alluvial tin may have been derived. The original source.

Roove (Eng.). To rub or knock against the roof. (Gresley)

Rope crab. An appliance used in cable drilling for recovering ropes that may have been accidentally dropped in the borehole. (Mitzakis)

Rope drilling. 1. Drilling in the ground with a bit attached to the end of a rope to which a twisting motion is given. Sometimes called Jump drilling, as the rope with the bit is raised and dropped.

Rope drive. A replacement of belts by ropes for driving machinery. (Power)

Rope driver. A person who looks after the rope and the equipment of the train of cars drawing coal from the mine, and superintends the movement of cars. (Stony Fork Coal Co., *v.* Lingar, 153 S. W. Rept., p. 6; Bell-Knox Coal Co. *v.* Gregory, 153 S. W. Rept., p. 465)

Rope haulage. Any haulage system in which the cars are attached to ropes. Usually employed on level or nearly level roads or entries; sometimes with an endless rope. *See* Tail-rope haulage.

Rope house. In salt manufacturing, an evaporating house. (Century)

Rope rider (Okla.). An employee whose duty it is to see that cars are coupled properly, and to inspect ropes, chains, links, and all coupling equipment. A trip rider.

Rope roll (Eng.). The drum of a winding engine. (Gresley)

Rope trip. A trip of cars handled by a rope. (Steel)

Ropeway. A line or double line of suspended ropes, usually wire, along which articles of moderate weight may be transported on slings, either by gravity or power; much used in mountainous mining districts for transportation to watercourses or to steam-railway lines (Standard). An aerial tramway.

Ropp furnace. A long reverberatory furnace over the hearth of which a series of plows or rakes is drawn by a continuous cable, moving the ore steadily from the feed to the discharge end. (Ingalls, p. 104)

Ropy lava. Same as Pahoehoe.

Rosca (Sp.). 1. Screw thread. 2. A ring or washer put around a drill when water is present. 3. In the *patio* process, silver left after retorting. (Halse)

Roscoelite. A vanadium-bearing muscovite mica in which Al_2O_3 is partly replaced by V_2O_3. The content of V_2O_3 may reach an equivalent of 28.85 per cent V_2O_5, though generally much less. (U. S. Geol. Surv.)

Rose. 1. (Scot.) The perforated nozzle of a water pipe. (Barrowman) 2. A diamond of such small size that it can be cut little if at all. (Webster)

Roseaker. An old name for Realgar. (Century)

Rose copper. Same as Rosette copper.

Rose head. A perforated nozzle, as for a sprinkler (Standard). *See* Rose, 1.

Rose porcelain. Chinese hard-porcelain brilliantly decorated with a red enamel. (Standard)

Rose quartz. Crystalline quartz with a rose-pink color. Used as gem or as an ornamental stone. *See* quartz. (U. S. Geol. Surv.)

Rose steel. A steel that shows a peculiar fracture and texture in the interior different from that near the surface. (Standard)

Rosette. A disk-like crust or plate of metal purposely formed on and removed from the surface of molten metal (Standard). *See* Rosette copper.

Rosette copper. Disks of copper (red from the presence of suboxide) formed by cooling the surface of molten copper through sprinkling with water (Raymond). Called also Rose copper.

Rose vitriol. Cobalt sulphate; bieberite. Also called Cobalt vitriol; Red vitriol. (Standard)

Rosh (Leic.). *See* Rait.

Rosicler (Sp.). 1. Ruby silver; *R. claro*, proustite; *R. negro*, stephanite; *R. oscuro*, pyrargyrite. 2. *R. de cobre* (Chile and Peru), cuprite. (Halse)

Rosin jack. A yellow variety of sphalerite. (Power)

Rosin tin. A reddish or yellowish variety of cassiterite. (Power)

Ross and Welter furnace. A multiple-deck roasting furnace of the annular type. Used in Germany. (Ingalls, p. 110)

Rossie furnace. An American variety of hearth for the treatment of galena, differing from the Scotch hearth in using wood as fuel, working continuously, and having hollow walls, to heat the blast. (Raymond)

Rosso antico marble. A red marble used by the Etruscans and ancient Romans; said to have been obtained from Cynopolis and Damaristica (Merrill). It has white markings and fine black veins.

Rosso levanto marble. *See* Verdantique.

Rosterite. A variety of pale rose-red beryl found in the granite of the Island of Elba, Italy. (Century)

Rosthornite. A resin ($C_{24}H_{40}O$) possessing a brown color and a specific gravity of 1.076, found at Sonnberge, Carinthia. (Bacon)

Rotary fault. *See* Fault.

Rotary puddler. A mechanical puddler in which the treatment of molten metal is effected by the rotation of the furnace. (Century)

Rotary pump. A pump in which the moving part is a piston, follower, or cam, rotating in a case, as distinguished from one that has a piston with to-and-fro motion (Standard). A centrifugal pump.

Rotary squeezer. A puddle-ball squeezer having a rotating drum mounted out of center in a cylindrical case. (Standard)

Rotator. A revolving or rotary furnace. (Century)

Rotch. *See* Rotche.

Rotche; Roche (So. Staff.). A soft and moderately friable sandstone (Gresley). Called also Roach; Rotch.

Rothoffite. A yellowish-brown to liver-brown, magnesian calcium-iron garnet. (Dana)

Rotten reef. (So. Afr.). Decomposed, soft, country rock found in connection with auriferous conglomerates. (Duryee)

Rottenstone. 1. A soft, light, earthy substance, consisting of silica in fine grains, resulting from the decomposition of siliceous limestone. (Roy. Com.).

Rouge antique marble. *See* Rosso antico marble.

Roughcast. 1. A kind of plaster made of lime, with a mixture of shells or pebbles, used for covering buildings. (Webster)
2. To roughen the surface of (pottery) before firing. (Standard)

Rough coal (Scot.). A name sometimes given to free coal when associated with gas coal or splint coal. (Barrowman)

Rough diamond. An uncut diamond.

Rougher cell. Flotation cells in which the bulk of the gangue is removed from the ore.

Roughing hole. A hole to receive slag from a blast-furnace, or molten iron when it is undesirable to let it run into pigs. (Standard)

Roughing mill. 1. A metal disk charged with an abrasive, used for the first work in grinding gems. 2. A set of roughing rolls. (Standard)

Roughing rolls. The rolls of a train which first receive the pile, ingot, bloom, or billet, and partly form it into the final shape (Raymond). Called also Breaking- or Roughing-down rolls.

Roughs; Rows (Corn.). Coarse, poor sands, resulting from tin dressing (Raymond)

Roughsetter. A building mason employed on coarse work. (Standard)

Roughway (Corn.). A quarry term to designate a direction along which there is no natural cleavage in a rock. *See* Cleaving way, and Quartering way. (Greenwell, p. 81)

Round coal (Eng.). Coal in large lumps, either handpicked or after passing over screens. (Gresley)

Round-edge slip. *See* Slip stone.

Rounder. 1. *See* Reamer, 1.
2. An indented cylindrical tool for rock-boring. (Standard)

Rounding-tool. A forming- or swaging-tool having a semicylindrical groove; a blacksmith's swage or collar-tool. (Standard)

Round ore. Same as Leap ore. (Standard)

Round rea (Scot.). A space at the shaft bottom where coal is stored. (Barrowman)

Roundstone. Small, roundish stones collectively, used for paving; cobblestone. (Century)

Round-strand rope. A rope made of round twisted-strands. (C. M. P.)

Row (pronounced *ro*). (No. Staff.) A seam or bed of coal. (Gresley)

Row (pronounced *rou*) (Corn.). Large, rough stones. (Raymond)

Rowlandite. Yttrium silicate, $2Yt_2O_3 \cdot 3SiO_2$. (U. S. Geol. Surv.)

Rows. *See* Roughs.

Royal agate. A mottled variety of obsidian. (Century)

Royal green. Paris green. (Webster)

Royalty. 1. (Eng.). The mineral estate or area of a colliery, or a portion of such property. A field of mining operations. (Gresley)
2. A seigniorage on gold and silver coined at the mint. 3. (Eng.). A percentage paid to the crown, of gold or silver taken from mines, or a tax in lieu of such share of the product or profit (Webster). *See* Acreage rent.
4. The amount paid by the lessee, or operator, to the owner of the land, mineral rights or mine equipment, based on a certain amount per ton or a per cent of total mineral production.

Rozan process. An improvement of the Pattinson process (Raymond). Also called Luce-Rozen process.

Rubasse (Fr.). A crystalline variety of quartz containing, distributed through it, spangles of hematite, which reflect a ruby red. Called also Ancona ruby; Mont Blanc ruby; *Rubace.* (Standard)

Rubber. 1. A gold-quartz amalgamator, in which the slime is rubbed against amalgamated copper surfaces. (Raymond)
2. (Scot.) A piece of wood for pump rods to slide on, or for hutches to rub on going round sharp curves. (Barrowman)
3. A bucking iron or bucking hammer. *See* Bucking.

Rubberide. A trade-name for an imitation of vulcanized rubber. (Century)

Rubberstone. A sharp-gritted Ohio or Indiana sandstone used for sharpening shoe knives; also called Shoestone (Merrill).

Rubbing bars (Aust.). Bars placed on the side of a cage nearest to the other cage when rope guides are used. The buffer ropes are placed outside for rubbing bars. (Power)

Rubbing bed. A circular disk of iron, or occasionally carborundum, rotating in a horizontal plane, upon which blocks of stone are placed in order to rub or grind away all irregularities. (Bowles)

Rubbing block. In marble working, a smoothing or polishing block. (Standard)

Rubbing brick. A heavy, coarse-grained stone generally artificial, used principally for rubbing down rough castings, smoothing concrete work and for dressing marble and granite. (Pike)

Rubbing stone. A gritstone for smoothing tool marks, etc., out of building stone, bricks, etc. (Standard)

Rubbing surface. The total area of a given length of airway; that is, the area of top, bottom, and sides added together, or the perimeter multiplied by the length. (Steel)

Rubbish (Eng.). Fallen stone from the roof; holing débris made in sinking, drifting, etc. (Gresley). Waste.

Rubble. 1. Water-worn or rough-broken stones, broken bricks, etc., used in coarse masonry. 2. Rough stone as it comes from the quarry. 3. A quarryman's term for the upper fragmentary and decomposed portion of a mass of stone; brash. 4. (Eng.) A hard chalk used in making paths. (Webster)

Rubble ashlar. Ashlar masonry with rubble backing. (Webster)

Rubble drift. A coarse agglomeration of angular débris and large blocks set in an earthy matrix of glacial origin. (Century)

Rubble ice. Ice in broken fragments, as in the Arctic seas. (Webster)

Rubble masonry. Rough, unsquared stone laid in irregular courses. (Merrill)

Rubbles (Eng.). Slack or small coal. (Gresley)

Rubble stone. 1. (Eng.). A name given by Kirwan to graywacke (Humble).
2. *See* Rubble.

Rubble work. Masonry composed of irregular or broken stone or fragments of stone mingled with cement or clay (Standard). Called also Rubble masonry.

Rubbly reef (Aust.). A vein much broken up. (Duryee)

Rubellite. Dark-pink or red tourmaline.

Ruberite. Same as Cuprite. (Century)

Rubi (Sp.). Ruby, a variety of spinel. (Halse)

Rubidium. A soft silvery metal which decomposes water with violence and inflames spontaneously in air. An alkali metal closely resembling potassium in general properties. Symbol, Rb; atomic weight, 85.45; specific gravity, 1.52. (Webster)

Rubio (Sp.). Limonite or brown hematite. (Halse)

Ruble. The monetary unit of Russia, equivalent to 51.5 United States cents. (Century)

Rubstone. A whetstone; also stone suitable for making whetstones. (Standard)

Ruby. Clear red corundum, Al_2O_3. A well-known gem. (U. S. Geol. Surv.)

Ruby arsenic. An early name for realgar (Chester). *See* Ruby sulphur.

Ruby blende. A red or brownish-red variety of transparent crystallized sphalerite (Standard). *See also* Ruby zinc.

Ruby copper. An early name for cuprite, from its color. (Chester)

Ruby luster. In ceramics, any red or reddish metallic luster. (Standard)

Ruby mica. An old synonym for Göthite. (Chester)

Ruby silver. *See* Proustite and Pyrargyrite.

Ruby sulphur. Same as Realgar (Standard). Called also Ruby arsenic; Ruby of arsenic; Ruby of sulphur.

Ruby zinc. A popular name for transparent sphalerite of a deep-red color, and also for zincite with the same characteristics. (Chester)

Ruck. 1. (Lanc.) The stock of coal on the bank. (Gresley)
2. A streak of pyrite in roofing slates. (Power)

Rud (Prov. Eng.). Red ocher. (Standard)

Rudding (No. of Eng.). The act of clearing away refuse rock.

Ruddle (Eng.). A common term meaning red, for a red variety of iron ore. (Roberts)

Rueda (Sp.). 1. A wheel. 2. *R. de mecha*, a coil of safety fuse. 3. (Mex.) A rounded mass of silver ore. (Halse)

Ruin (Eng.). A term occasionally employed in familiar description for certain minerals whose sections or cut faces exhibit the appearance of ruined buildings, as Ruin agate, Ruin marble, etc. (Page)

Ruin agate. *See* Ruin.

Ruiniform. Having the form or appearance of ruins, as certain minerals.

Ruin marble. *See* Ruin.

Rull (Eng.). To wheel or trundle, as ore. (Webster)

Ruller (Corn.). A workman who wheels ore in a wheelbarrow underground. (Raymond)

Rumanite. A yellow amber-like resin obtained from Rumania. (Bacon)

Rumbadero (Colom.). An ore chute or ore pass. (Halse)

Rumbo (Sp.). Direction; strike of a vein. (Dwight)

Rumbón (Colom.). 1. An automatic inclined plane. 2. An inclined chute for ore or timber. (Halse)

Run. 1. Direction, as of a vein. 2. Caving in of a working, etc. 3. A fall of the cage in a shaft due to a failure in the hoisting apparatus. 4. An inclined passage between levels. 5. A settling trough for slimes. 6. An irregular ore body. 7. Horizontal distance to which a drift is or may be carried. 8. In quarrying, a direction of secondary or minor cleavage grain. *See* Rift. (Webster)
9. The length of time reduction works or a mine is kept in operation without stopping to clean up, make repairs, or for other purposes. (Hanks)
10. By the run. A method of paying coal miners per linear yard of breast excavated instead of by the amount of clear coal produced. (Raymond)
11. A journey. 12. A word commonly made use of to express the degree of leverage or breaking-down power of a shot. 13. (Eng.) To work a winding, or other, engine.

14. Soft ground is said to "run" when it becomes mud and will not hold together or stand. (Gresley) 15. To make by pouring melted metal into molds; mold; found. 16. An act of flowing, or that which flows. Especially: (a) The quantity that flows at one time or during one operation or period; as, a *run* of iron in a melting-furnace. (b) A single operation of pouring or casting in a foundry. (Standard) 17. (Corn.) To quit a piece of work before it is quite finished. (Pryce)

Runaround. A passage driven in the shaft pillar to enable men and animals to pass safely from one side of the shaft to the other side. *See* Bye-pass, 1.

Runaway switch (Aust.). A switch by means of which a runaway car can be sidetracked. (Power)

Run-back water (Scot.). Water from a set of pumps that is run back and pumped up again in order to keep the pump from going "on air" while the other pumps are at work. (Barrowman)

Rung; Rundle; Round. A step or crossbar of a ladder. (C. and M. M. P.)

Runnel. A rivulet or small brook. (Duryee)

Runner. 1. The channel through which molten metal is conducted from the blast furnace or cupola to the pig bed, converter, or molds. *See* Pig iron. (Raymond) 2. (Eng.) A movable bridge or platform over the mouth of a shaft. Also called Jiddy. 3. A fault slip. 4. A crowfoot. 5. (York.) A flat piece of timber placed above bars, and connecting them. 6. (Leic.) The piece of timber placed in a horizontal position between the two inclined sprags in cokermegs. (Gresley) 7. (Scot.) A man or boy who goes with a train of cars in mechanical haulage. (Barrowman) 8. A steel-shod poling board, driven into unbroken but loose ground as excavation progresses. (Webster) 9. A man or boy who runs the loaded cars by gravity from the face of a room or chamber to the haulage road, controlling the speed by means of a brake or sprags. 10. An engineman; a machine runner. 11. A stone slab or rubber moved over a stone surface to polish it. 12. A horizontal channel in the sand of a mold from the bottom of the gate to the space left by the pattern. 13. Any pouring-gate. 14. The metal left in such channel attached to the casting and requiring removal. (Standard) 15. (So. Staff.) A runaway cage or skip, due to failure of brakes or breaking of cable. (Min. Jour.)

Runner-on. *See* Bottomer.

Runner stick. A slightly tapering round stick, used as a pattern for the opening through which molten metal is to be poured into the mold. (Standard)

Running amain (Scot.). The running of a winding rope down into the shaft, due to failure of brake or other appliances. (Gresley)

Running balk (Eng.). A set of timbers in the direction of a drift (at its side instead of across it) to form a support for the crosspieces. A running balk at each side, with balks or planks supported by them, is the common method of timbering through an old bord or place where the roof has fallen badly. (G. C. Greenwell)

Running bridge (Aust.). A platform, on wheels, that serves as a cover for a shaft in process of sinking, and on which buckets or skips are landed. *See* Runner, 2. (Power)

Running ground. Superincumbent material that breaks off readily and falls into the mine openings. (Weed). Earth and rock that falls, runs, or caves in (Standard). Quicksand.

Running gug (Som.). A self-acting incline. (Gresley)

Running kiln. A lime kiln that is fed from above, and delivers continually below. (Standard)

Running lift (Eng.). A sinking set of pumps so constructed as to lengthen or shorten, at will, by means of a sliding or telescopic water column. (Gresley)

Running measures (Eng.). Sand and gravel containing much water. (Gresley)

Running-off. In founding, the opening of the tap hole of a blast furnace and allowing of the molten metal to flow out to the molds. (Standard)

Running roll. A cylinder used in plate-glass manufacturing for spreading the soft glass on the casting table. (Standard)

Running rope. A flexible rope that will pass through blocks, and used for lifting or for moving heavy objects.

Running sand. Quicksand.

Running the drum (Eng.). The lowering or sinking of a cylinder or drum through quick ground, to secure the upper part of a mine shaft. (Gresley)

Run-off. 1. That part of the natural precipitation that flows off the surface of the land in the form of visible streams. (Watson, p. 244)
2. To cause the contents of to flow off or out; as, to *run-off* a millpond or a smelting furnace. (Standard)
3. The collapse of a coal pillar in a steeply pitching seam, caused either naturally or by a small shot placed in it. This occurs in connection with pillar robbing, and the pillar is said to have *run-off*.

Run of lode (Corn.). Its direction or course. (Min. Jour.)

Run of mine. Coal as it is dug in the mines, including lump and fine coal together, without any preparation or screening. (Nicolls)

Run of ore. *See* Shoot of ore.

Run of the rock. Same as Run, 8. A direction of easy splitting in a rock, but subordinate in ease to the rift direction. (Bowles)

Run-out fire. A forge in which cast-iron is refined. (Raymond)

Run rider (Eng.). A lad who goes with a train (trip) on an engine plane (Gresley). A trip rider.

Runs (Eng.). Percentage of metal in the ore (Skinner). The ore *runs* (contains) 10 per cent copper.

Run-steel. Malleable castings. (Raymond)

Run-the-tow. 1. (Scot.). To cause the cages to traverse the shaft preparatory to allowing men to descend. (Barrowman)
2. (Scot.) Sliding down the shaft on the winding rope. (Gresley)

Rush. 1. A moving forward with rapidity and force (Webster). As a rush of ore.
2. (Scot.). The sudden weighting of the roof when robbing the pillars begins. (Gresley)
3. A sudden movement of a large number of miners to some new locality. *See* Stampede. (Hanks)
4. *See* Spire, 1.
5. (Aust.). An area containing gold, and hence causing miners to rush for it. (Standard)

Rusher. One who rushes into a region when it is first opened to settlement, or, on a discovery of precious metal (Standard). A Stampeder.

Rush gold. Gold coated with oxide of iron or manganese (C. and M. M. P.). Rusty gold.

Rusks (No. of Eng.). Small slack, or that coal next larger than dust. (Gresley)

Russell process. A metallurgical process similar to the Patera process, which *see*, except that cuprous-sodium hyposulphite is used in addition to the sodium hyposulphite. (Liddell)

Russia iron. A high-grade, smooth, glossy sheet-iron, not liable to rust, once made by a process that was long a secret with Russian manufacturers. The sheets were subjected to severe hammering in piles with powdered charcoal between them. (Standard)

Russol. A trade name for liquid petrolatum. (Bacon)

Rust. 1. The reddish or yellowish coating caused on iron or steel by oxidation, as by the action of air and moisture, consisting of ferric hydroxide and ferric oxide, or red oxide of iron; in an extended sense, a film or oxide formed on any metal by corrosion. 2. A mixture of iron-filings, ammonium chloride, and sometimes sulphur, moistened and placed between iron surfaces, where it hardens by oxidation, and forms a solid joint called a *rust-joint*. (Standard)

Rust ball. 1. A lump of yellow iron ore found in the chalk, in Cambridgeshire, England. 2. Such material collectively. (Standard)

Rustic ware. Brown, glazed, buff, or light-brown terra-cotta, sometimes green mottled: used for ornament in construction. (Standard)

Rustle (Local U. S.). In brickmaking, to increase the heat of (a kiln). (Standard)

Rusty. 1. Covered or affected with rust. 2. Impaired by inaction, disuse, or neglect. 3. Rust colored; dark. (Webster)
4. Applied to coal discolored by water or exposure, as well as to quartz, etc., discolored by iron oxide. (Raymond)

Rusty gold (Cal.). Free gold, that does not readily amalgamate, the particles being covered with a siliceous film, thin coating of oxide of iron, etc. (Hanks)

Rute. 1. In mining, thread-like veins of ore. (Standard)
2. (Derb.) *See* Scrin, 2.

Ruthenium. A rare element of the platinum group, associated with platinum ores, and separated as a hard, brittle, steel-gray metal, very infusible and almost insoluble in acids. Symbol, Ru; atomic weight, 101.7; specific gravity 12.26. (Webster)

Rutile. Tetragonally crystallized titanium dioxide, TiO_2. Octahedrite is another tetragonal form with different facial angles. When crystallized in orthorhombic form titanium dioxide is known as brookite. (Dana)

Rutilated quartz. Quartz penetrated by needles of rutile. (A. F. Rogers)

Ruttles (York.). Shattered and faulty ground running roughly parallel to the plane of a fault. (Gresley)

S.

Sabana (Colom.). An alluvial mine on a river bank above the level of the water. (Halse)

Sable iron. A superior kind of Russian iron originally stamped with the figure of a sable. (Webster)

Sabotage (Fr.). Malicious waste or destruction of an employer's property by workmen during labor troubles. (Webster)

Saca (Sp.). 1. Exportation. 2. Extraction of the gold from auriferous sands. 3. (Mex.) Ore raised from a mine in a given time. 4. (Mex.) An ore sack. 5. *Mina de saca* (Colom.), an alluvial mine in which the pay gravel or sand is below water level. (Halse)

Sacabuches (Sp.). Hand pumps. (Min. Jour.)

Sacados (Colom.). Filled-up stopes. (Halse)

Sacar (Sp.). To draw or bale out; *S. con bomba*, to pump; to extract ore from a mine. (Halse)

Saccharoidal. Having a granular texture resembling that of loaf sugar; said of some sandstones and marbles. (La Forge)

Saccharoidal marble. Any marble having a granular crystalline structure like that of loaf sugar. (Merrill)

Saco (Sp.). 1. A sack or bag. 2. *Criaderos en saco*, irregular deposits of ore filling superficial cavities or crevices. (Halse)

Saddle. 1. (Aust.) A formation of gold-bearing quartz occurring along the crest of an anticlinal fold. 2. A ridge connecting two higher elevations; a low point in the crest line. (Webster) A ridge whose strata dip away downward from the central axis on each side; an elevated anticlinal fold.
3. "A saddle is a peculiar formation found in shale or sand rock in the roof of a mine. The under or exposed side looks like natural rock, but its upper side is smooth, having no particular bond with the sand rock with which it is embedded, and is liable to fall out of its place, a fall, however, producing no other derangement of the surrounding parts of the room from which it falls" (Lehigh Valley Coal Co. *v.* Washko, 281 Fed. Rept., 42, p. 48). *See* Kettle bottom, which would seem to be a better term.

Saddle back. 1. A hill or ridge having a concave outline at the top. (Webster)
2. (Eng. and Scot.) A roll or undulation in the roof or pavement of a seam (Barrowman). *See also* Saddle, 3.
3. Two timbers placed so as to form an inverted V and used as a support for a load above. (Sanders, p. 45)

Saddler. A man employed to make and repair harness, etc., for the draft animals at a mine.

Saddle reef (Aust.). A bedded vein that has the form of an anticline; an *inverted saddle* has the form of a syncline. *See* Saddle, 1. (Power)

Saddle shaped. In the form of an anticlinal fold. (Webster)

Safeguards. The precautions taken to prevent men from being injured; guard rails, automatic signals, warning signs, etc.

Safety cage. A cage, box, or platform used for lowering and hoisting miners, tools, etc., into and out of mines, and which is provided with a "safety clutch," an automatic device for preventing the fall of the cage if the supporting cable breaks. (Hanks)

Safety car. 1. Any mine car or hoisting cage provided with safety stops, catches or other precautionary devices.
2. (Penn.) A barney; a small car used on inclined planes and slopes to push up a mine car. (Century)

Safety catch. An automatic device for preventing the fall of a cage in a shaft or a car in an incline if the supporting cable breaks. (Raymond)

Safety chain (Scot.). A chain connecting the first and last cars of a trip to prevent separation, if a coupling breaks. (Barrowman)

Safety detaching-hook. A self-acting device that releases the cage from its hoisting rope in case of an overwind. (Power)

Safety door. A strongly constructed door hinged to the roof of the mine, and always kept open and hung near to a main door, for immediate use in case of damage by explosion or otherwise to the main door. (Gresley)

Safety first. A term often applied to accident prevention methods, and first-aid and rescue work. As a slogan, was first used nationally by Dr. Joseph A. Holmes, the first director of the U. S. Bureau of Mines, at the national mine safety meet in Pittsburgh, Pa., in 1911. A Middle West steel company claims to have originated the expression, but it did not come into national use until taken up by the Bureau of Mines. The bureau, unconscious of its use in any other place, made up the slogan from a program of the H. C. Frick Coal & Coke Co., for a safety meet which stated "Safety ahead of output," "Safety ahead of dividends," "Safety the first consideration." The Bureau of Mines shortened these expressions into "Safety first."

Safety fuse. A fuse consisting of a cotton or hemp tube holding a slow-burning composition for exploding charged blast holes. Commonly called Fuse. (Webster)

Safety gate. An automatically-operated gate placed at the top of a mine shaft, or at landings, to guard the entrance, to prevent anyone from falling into the shaft.

Safety hook. 1. *See* Safety detaching-hook. 2. A hook, shut by a spring or other device, to prevent an article from being accidentally or forcibly detached from a chain. 3. A safety catch in a mine hoist. (Standard)

Safety lamp. A lamp, the flame of which is so protected that it will not immediately ignite fire damp. There are several varieties, invented by Davy, Stephenson, Clanny, and others (Raymond). The flame is generally surrounded by a cylindrical covering of wire gauze, that protects the surrounding atmosphere from being fired, even though the gases within the lamp have reached the explosive proportions. When fire damp enters the lamp it burns, forming a bluish "cap" over the lamp flame, whence safety lamps are used in testing for this gas. The foregoing is a flame safety lamp as distinguished from the electric safety lamp in which the gas can not come in contact with the incandescent filament that produces the light. *See* Electric safety lamp. For a history of the safety lamp *see* Trans., Institution of Mining Engineers (England), vol. 51, pp. 548–724.

Safety plug. In steam boilers, a bolt having its center filled with a fusible metal, screwed into the top of the fire box so that when the water becomes too low the increased temperature melts out the metal, and thus admits steam to the fire box to put out the fire. (Century)

Safety powder. A term used for short flame explosives before the introduction of permissible explosives.

Safety stop. 1. On a hoisting apparatus, a check by which a cage or lift may be prevented from falling. (Standard)
2. An automatic device on a hoisting engine designed to prevent overwinding.

Safety tools. Consist of catching hooks, grappling tongs, fish-heads, bell-screws, and the like, for recovering broken boring tools, picking up material, etc., at the bottom of bore holes. (Gresley)

Sag. 1. A depression in a coal seam. (Steel)
2. To sink in the middle by weight, below a horizonal line, as a cable when supported at both ends. (Webster)

Sagene; Sajene. A Russian measure of length of 7 ft., or 2.134 meters. (Webster)

Sagenitic quartz. Quartz containing included acicular crystals of rutile (then called *Venus's hairstone*) or sometimes similar crystals of black

tourmaline, goethite, stibnite, asbestos, actinolite, hornblende, and epidote. (Standard)

Sagger. 1. In ceramics, a box made of fire clay in which delicate pieces are placed while being baked. Spelled also Saggar; Saggard; Seggar; Sagre. 2. The clay of which saggers are made. 3. A box in which cast-iron articles are placed in contact with hematite or smithy scales, to be rendered malleable by decarbonizing in the annealing furnace. (Webster)
4. A local term for fire clay, often forming the floor (or thill) of coal seams.

Sagre; Seggar. *See* Sagger.

Sagvandite. A curious rock from near Lake Sagvand, Norway, that is mainly bronzite and magnesite. A little colorless mica, and more or less chromite and pyrite are also present. The name was given by Petterson. (Kemp)

Sahia (Port.). A blown-out shot. (Halse)

Sahlite. A variety of pyroxene. The term is sometimes prefixed to rock names. (Kemp)

Sailor. A term sometimes employed for rigger, painter, or structural worker at blast furnaces. (Willcox)

Saint Anne marble. A deep blue-black white-veined marble from Biesme, in Belgium. (Merrill)

Saint Baume marble. A yellow stone veined with brown or red; from the province of Var, France. (Merrill)

Saint Peter's sandstone. An early Ordovician formation in Wisconsin and Minnesota. (Webster)

Saint Quirinus oil. Petroleum used medicinally in Germany as early as 1436, the supply coming from the Tegernsee district of Bavaria. (Bacon)

Sal (Sp.). 1. Salt; *S. piedra*, rock salt; *S. de manantiales*, brine salt; *S. de tierra*, salt mixed with earthy impurities; *S. marina*, sea salt; *S. mineral*, salt for amalgamation. (Halse)

Salamander. A mass of fused, but solidified, material in the hearth of a blast furnace, usually largely metallic iron, partly reduced ore, etc. Called also Bear, Sow, or Shadrach. In copper smelting it contains metallic copper and matte.

Salamanders' hair. Asbestos. (Standard)

Sal ammoniac. Ammonium chloride, NH_4Cl. (Dana)

Salamstone. A variety of sapphire, usually in small, transparent, hexagonal prisms of pale-red or blue, found chiefly in Ceylon. (Standard)

Salina; Salar (Chile). A saline deposit. (Halse)

Salband. A term current among miners for the parts of a vein or dike next to the country rock. (Kemp)

Salbanda. 1. (Mex.) Slickensides. (Dwight)
2. (Sp.) Flucan; a thin layer of clay between the vein and wall rock. (Halse)

Salic. Pertaining to, or belonging in, the first or sal group of standard minerals, in the quantitative or norm classification of igneous rocks; often incorrectly used to mean persilicic, felsic, or leucocratic. (La Forge)

Saliferous. Containing a considerable proportion of salt in beds, or as brine; said of strata. (Standard)

Saliferous system. An old name for Triassic; So called because of its rich salt deposits in Europe. (Standard))

Salimeter. An instrument for measuring the amount of salt in a solution. (Webster)

Salina. 1. A salt marsh, or salt pond, inclosed from the sea. 2. Salt works. 3. A subdivision of the American Silurian, including the important salt beds in New York and adjoining beds; now obsolete. (Webster)

Saline. 1. A salt spring or well; salt works. (Raymond)
2. Applied to minerals having the taste of common salt. (Dana)

Saline dome. An up-swelling of the earth's surface on the coastal flats of Louisiana and Texas, one-fourth to one mile in diameter, often showing a marshy depression at the summit with escaping oil or gas, or both, around the periphery of the dome. The center is barren of vegetation, consisting of a nucleus of salt. (*See* Salt dome; *also* Dome, 5.

Salinero. 1. (Sp.) Applied to ores requiring much salt in amalgamation. 2. A dealer in salt; an owner of a salt mine or works. (Halse)

Salines. As used by Congress, includes not only salt springs but all salt lands of every character. (Southwestern Mining Co., In re, 14 Land Decisions, p. 600)

Saliniferous. Yielding salt, as a saltbed. (Standard)

Salinometer. A hydrometer graduated to show the percentage of salt in a solution: used in one form to indicate the proportion of salt in a marine boiler (Standard). *See* Salimeter.

Saliter. Soda niter. (Standard)

Salites. A term employed by M. E. Wadsworth to include all salts and saline materials. (Power)

Salitral. A swampy place where certain salts, as saltpeter, become incrusted in the dry season. (Standard)

Salitre. 1. (Sp.) Saltpeter or nitrate of potassium. 2. (Chile) Sodium nitrate. (Halse)

Saller (Corn.). 1. A chamber in a mine. 2. A stage to work on. 3. A boarded channel for water to run in along the bottom of an adit. 4. The floor or stage on which the ladders rest in a shaft (Davies). Also spelled Solar, Sellar, Sollar, and Soller, *Sollar* being preferable.

Salmon brick. A class of brick embracing those not hard enough for outside walls, and including *soft, salmon, backing-up, pale, light, chimney, filling-in, inside wall,* and *foundry* brick. (Standard)

Salmuera (Sp.). Brine. (Dwight)

Sal-natron. Crude soda ash: so called by dyers, soap-makers, and others. (Standard)

Salón (Mex.). 1. A cavern containing ore; a chamber deposit. 2. A bunch of ore that has been worked out. 3. (Colom.) Any enlarged place in an adit, made in order to facilitate and simplify the work. (Halse)

Salse. Eruptions of hot acidulated mud from small orifices, generally in volcanic districts, and often accompanied by steam and gases at high temperature. (Power)

Salt. 1. Halite; common salt. Sodium chloride, NaCl. (Dana) 2. In chemistry, any class of compounds formed when the acid hydrogen of an acid is partly or wholly replaced by a metal or a metal-like radical; as ferrous sulphate ($FeSO_4$) is an iron salt of sulphuric acid, H_2SO_4. 3. To place gold, or any valuable ore in the ground, a mine, or the like to give a false impression of the richness of the property. To "salt" a mine. (Webster)

Salt block. 1. An apparatus for producing salt by evaporation. 2. A salt factory where the evaporating process is used; saltern. (Standard)

Salt bottom. A flat piece of alkali ground. (Webster)

Salt cake. Sodium sulphate obtained as a white caked mass, usually by heating common salt with sulphuric acid, and used in the manufacture of soda by the Leblanc process, in glass making, etc. (Webster)

Saltcat. A lump of salt made at a salt works. (Webster)

Salt cote. A salt pit. (Webster)

Salt dome. *See* Saline dome. These domes are formed by strata being lifted or swollen upward by the increase in volume of salt and sulphur during deposition. *Compare* Dome, 5.

Saltern. 1. A building or place where salt is made by boiling or by evaporation; salt works. (Webster) 2. A plot of clayey ground where salt is obtained by evaporating seawater in the sun; salt garden. (Standard)

Salt flour. Potassium nitrate in the form of fine crystals. (Webster)

Salt furnace. A simple form of furnace for heating the evaporating pans and boilers in a salt factory. (Century)

Salt garden. A saltern where sea water or brine is naturally evaporated in large shallow basins (Webster). *See* Saltern, 2.

Salt glaze. A glaze produced on pottery by volatilizing common salt in the kiln after partial firing. (Webster)

Salt horse. A quarryman's term for aplite (Perkins). *See* Salt vein.

Saltierra (Mex.). 1. One of the saltbasins formed by the drying up of salt lakes. (Standard) 2. Earthy, impure salt. (Dwight)

Salting. (Eng.) Sprinkling salt upon the floors of underground ways in very dry mines, in order to lay the dust. (Gresley)

Salting a mine. Sprinkling particles of gold or rich ore upon or digging them into the ground to make the mine appear rich in mineral. It is done with intent to defraud. (Cook *v.* Johnson, 3 Alaska, p. 519; Healey *v.* Rupp, 28 Colorado, p. 102: 63 Pac. 319; Southern Development Co. *v.* Silva, 125 United States, p. 253). *See* Salt, 3.

Salt lick. A place where salt is found on the surface of the earth to which animals resort to lick it up. (Webster)

Salt mine. A mine in which rock-salt deposits are worked. (Standard)

Salto (Sp.). A fault, throw or slide. (Halse)

Salt of phosphorus. Sodium ammonium phosphate; a reagent used in blow-pipe analysis. (A. F. Rogers)

Salt of tin. A mordant made by dissolving tin in hydrochloric acid; stannous chloride; tin salt. (Standard)

Salt of vitriol. *See* White vitriol.

Salt pan. 1. A shallow lake of brackish water. (Power)
2. A large pan for making salt by evaporation. 3. A salt works. (Webster)

Saltpeter. Potassium nitrate. One of the principal ingredients of black blasting powder.

Salt pit. A pit where salt is obtained; a salt pan. (Century)

Salt prairie. A tract of level land covered with a whitish efflorescence of natron or soda and presenting an aspect of utter desolation; common in New Mexico, Arizona, and Texas. Called also Soda prairie. (Standard)

Salt spring. A spring of water containing a large quantity of common salt (Comstock). (U. S. Min. stat., 1194–1214)

Salt vein. A term applied by quarrymen to a coarse granite vein from 2 inches to 2 or more feet thick, intersecting granite or any other crytalline rock (Merrill). *See* Salt horse.

Salt well. A bored or driven well from which brine is obtained. (Standard)

Salt works. A place where salt is made on a commercial scale. (Webster)

Salvapoleas (Sp.). An apparatus to protect hoisting pulleys against overwinding. (Halse)

Samarium. A rare metallic trivalent element found in association with yttrium, cerium, etc. It has a whitish-gray color. Symbol, Sa; atomic weight, 150.4; specific gravity, 7.7. (Webster)

Samarskite. A columbate and tantalate of uranium, the cerium metals, the yttrium metals, and minor quantities of other metals. (U. S. Geol. Surv.)

Sample. 1. A portion of the ore (coal, metal, etc.) systematically taken, by which its quality is to be judged. 2. To select or take at random a sample or specimen, as of ore, coal, etc. 3. To try, or test.

Sample cutter (Scot.). A steel tube with teeth at the end for cutting cores of mineral in boring. (Barrowman)

Sampler. 1. A mechanical device for selecting a certain fractional part of ore to be used as an assay sample; as for example, split shovel; riffle sampler; Brunton's mechanical sampler and Vezin sampler. (Hofman, p. 54)
2. One whose duty it is to select the samples for an assay, or to prepare the mineral to be assayed, by grinding and sampling. (C. and M. M. P.)

Sampling. 1. Cutting a representative part of an ore (or coal) deposit, which should truly represent its average value. Most usually a trench-like cut 4 inches wide and 2 inches deep is cut into the clean face of ore (or coal) and across its course. Honest sampling requires good judgment and practical experience. (Weed)
2. Selecting a certain fractional part of ore or coal from cars, stock piles, etc., for analysis.

Sampling works. A plant and its equipment for sampling and determining the value of ores that are bought, sold, or treated metallurgically.

Sampson post; Samson. An upright post which supports the walking beam, communicating motion from the engine to a deep-boring apparatus. (Raymond)

Sana birro (W. Afr.). Gold nuggets. (Lock)

Sana ku (W. Afr.). Gold washing. (Lock)

Sana manko (W. Afr.). Gold powder. (Lock)

Sand. 1. Separate grains or particles of detrital rock material, easily distinguishable by the unaided eye, but not large enough to be called pebbles; also, a loose mass of such grains, forming an incoherent arenaceous sediment. (La Forge) *Building sand*, any hard, granular rock material finer than gravel and coarser than dust. The term indicates material comminuted by natural means. Quartz grains generally predominate in natural deposits, although such deposits commonly contain many other minerals. *Glass sand*, a sand of medium grain consisting of 98 to 100 per cent of silica (SiO_2), used in glass making. Iron oxides should form less than 1 per cent of the mass. *Molding sand*, a sand used in making molds for casting metal. (U. S. Geol. Surv.) 2. In geology, any loose or moderately consolidated bed consisting chiefly of sand; often used in the plural, even in the name of a single deposit. 3. Specifically, sandstone; a technical usage in petroleum regions. (Standard)

Sand bar. A bar of silt formed by currents in rivers and at their mouths, or of sand formed along beaches by tidal action. (Standard)

Sand bath. A vessel of hot sand in a chemical laboratory in which vessels to be heated are immersed. (Webster)

Sand bearings. The supports of a core in the sand of a mold. (Standard)

Sand bed. 1. The bed into which molten metal from a blast furnace is run. 2. A floor of a foundry, in which large iron castings are made. (Standard)

Sand blast. 1. A mudcap in which sand is used instead of mud. (Du Pont) 2. A stream of sand forcibly projected by air or steam for removing scale from metals. 3. The apparatus used to apply it. (Webster)

Sand-burned. Said of a metal casting, having a hard skin due to the silica of the sand combining with the surface of the metal when the latter is poured into the molds at high temperature. (Webster)

Sand crusher. An arrastre-like apparatus for breaking up and washing sand for glass making. (Standard)

Sand dike (Scot.). A wall of sand or gravel. (Barrowman)

Sand drift (Eng.). A general term for all wind-blown sands, whether occurring in inland deserts or along the seashores. (Page)

Sand dune. A mound, ridge, or hill of loose sand, heaped up by the wind.

Sanders process. A flotation process which uses, instead of an acid bath in deep pans, a dilute solution of aluminum sulphate in shallow pans. (Liddell)

Sand flag. Fine-grained sandstone, cleavable into flagstones. (Standard)

Sand flaw. In brickmaking, a flaw caused by imperfect mixture of the clay with sand; sand crack. (Standard)

Sand flood. A vast body of sand moving or borne along a desert, as in Arabia. (Century)

Sand gall. *See* Sand pipe.

Sand holder. A cavity in a pump-barrel to catch sand and keep it out of the way of the plunger or buckets. (Standard)

Sanding. In ceramics, the testing of gilding with fine sand and water after firing. (Webster)

Sandiver. A neutral salt skimmed off the surface of melted crown glass. Also called Gall of glass. (Ure)

Sandix. A kind of minium, or red lead, made by calcining carbonate of lead. (Webster)

Sand jack. A device consisting essentially of a sand box and a series of plungers for gradually lowering into position a heavy weight, supported by the plungers, by running out the sand below. (Webster)

Sand line. In well boring, a wire line used to lower and raise the bailer or sand pump, which frees the borehole from drill cuttings. (Nat. Tube Co.)

Sand pile. A filling of sand rammed hard in a deep round hole made by driving and withdrawing a wooden pile. Used in preparing foundations in soft soil. (Webster)

Sand pipe. A tubular cavity from a few inches to many feet in depth occurring in calcareous rocks, and often filled with gravel, sand, etc. Also called Sand gall. (Webster)

Sand pump. 1. A cylinder with a valve at the bottom, lowered into a drill hole from time to time to take out the accumulated slime resulting from the action of the drill on the rock. Called also Shell pump and Sludger. (Raymond)
2. A pump for lifting tailings at ore-dressing plants. (Clennell)

Sand reel. A windlass for working a sand pump in well boring. (Standard)

Sandrock. Same as Sandstone.

Sand roll. A metal roll cast in a mold of sand; distinguished from a *chilled roll*, which is cast in an iron mold or chill. (Standard)

Sands. 1. The coarser and heavier portions of the crushed ore in a mill. (Clennell, p. 34)
2. Tailings from the stamp mills of Lake Superior copper mines. (Weed)
3. *See* Sand, 2 and 3.

Sand scratches. Scratches or furrows worn in a rock surface by wind-blown sand. Such appearances are apt to be mistaken for glacial marks and require careful observation. *Compare* Glacial striæ.

Sand seam. A quarry term for a more or less minute vein or dike of muscovite (white mica) with some quartz, in cases also with feldspar. (Perkins)

Sandstone. An indurated sedimentary rock formed of coherent or cemented sand. (La Forge)
The following are common varieties: *Asphaltic* sandstone. A loose-textured sandstone containing asphalt. *Bluestone.* A tough bluish sandstone used for flagging. *Brownstone.* A sandstone of brown or reddish-brown color. Used for building. *Building sandstone.* Any sandstone suitable for building. *Flagstone.* A sandstone which cleaves into flags suitable for sidewalks and areaways. Includes most bluestone. *Freestone.* A sandstone which cuts with equal ease in any direction. Used for building. (U. S. Geol. Surv.)

Sandstone grit. 1. In geology, a coarse angular-grained sandstone. 2. In commerce, a sandstone well adapted for abrasive purposes and not necessarily having a coarse grain. (Bowles)

Sand streaks. Same as Sand seams. (Perkins)

Sand trap. A device for separating sand and other heavy particles from running water. (Century)

Sand washer. An apparatus for separating sand from earthy substances. (Century)

Sand (or Tailings) wheel (Mich.). A large wheel, having buckets on its inner perimeter, for elevating water and stamp-sand (Weed). Used as part of a tailings-disposal plant.

Sang de boeuf (Fr.). Literally, bullock's blood; a dark red of varying shades characterizing a certain kind of antique Chinese pottery and imitated in modern ware. (Standard)

Sangrar (Sp.). 1. To tap a furnace. 2. To drain a canal, river, or flume. (Halse)

Sangria (Sp.) 1. A crosscut from shaft to vein. (Dwight)
2. The act of tapping a furnace. 3. The stream of molten metal that comes from a furnace. (Halse)

Sanguinaria (Sp.). 1. Bloodstone, of a dark-green color, variegated by red spots. 2. Hematite. (Halse)

Sanidine; Sanidin. A glassy variety of orthoclase. (Dana)

Sanidinite. 1. A variety of syenite consisting predominantly of orthoclase; orthosite. 2. A variety of trachyte found in volcanic bombs and consisting almost wholly of sanidine (orthoclase). (La Forge)

Santorinite. A name proposed by H. S. Washington for those exceptional andesitic or basaltic rocks, which, with a high percentage of silica (65–69), yet have basic plagioclases, of the labradorite-anorthite series. The name was suggested by the volcano Santorini. The prevailing bisilicate at Santorini is pyroxene. (Kemp)

Sanukite. Weinschenk's name for a glassy phase of andesite that contains bronzite, augite, magnetite, and a few large plagioclases and garnets. The rock is related to the andesites as are the limburgites to the basalts. (Kemp)

Sap. 1. The part of the rock in a quarry which is next to the surface or to joints and crevices and has been somewhat stained and softened by weathering. (La Forge)
2. (Military) A deep, narrow ditch dug from an advanced parallel in the direction of a fortification, as for the advancement of siege-works. (Standard)

Sapo (Mex.). A railway frog. *See also* Rana. (Dwight)

Saponification. Conversion into soap; the process in which fatty substances form soap, by combination with an alkali (Rickard). A term used in the flotation process.

Saponifier. Any compound, as a caustic alkali, used in soapmaking to convert the fatty acids into soap. (Standard) A term used in the flotation process.

Saponite. A soft, massive, hydrous silicate of magnesium and aluminium, having a white, yellowish, grayish-green, bluish or reddish color, a greasy luster, and which occurs in cavities in basalt, diabase, etc. (Dana)

Sapper; Sappare. Same as Cyanite, which *see.*

Sapphire. Clear blue corundum, Al_2O_3. A well-known blue gem. There are also white, pink, and yellow sapphires. (U. S. Geol. Surv.)

Sapphire quartz. A rare blue variety of quartz. (Webster)

Saprolite. Disintegrated rock, from which the most easily soluble constituents have been removed, but which remains in place and still displays some of its texture and structure; the material formed during the intermediate stage of the decay of rocks. (La Forge)

Sarcophagus. A kind of limestone, used by the Greeks for coffins. (Standard)

Sard. A clear, red chalcedony, pale to deep in shade; also brownish red to brown. (Dana)

Sardachate. A variety of agate with reddish bands of carnelian; carnelian agate. (Standard)

Sardar (India). A mine foreman; a variant of Sirdar.

Sardina (Mex.). A crosscut saw. (Dwight)

Sardinianite. A variety of anglestie, $PbSO_4$, that crystallizes in the monoclinic system. (Standard)

Sardonyx. A variety of chalcedonic quartz (Dana). *See also* Sard.

Sarrancolin marble. One of the most beautiful of foreign marbles. The prevailing colors are red, white, brown, green, and orange, in veins and blotches; from the valley of Aure, in the French Pyrenees. (Merrill)

Sarsen (Eng.). 1. One of the large sandstone blocks scattered over the English chalk downs. Also called Sarsen stone and Druid stone (Webster). Also spelled Saracen and Sarcen. *See* Graywether.
2. One of the early inhabitants of southwestern England; especially, a former worker of the tin mines of Cornwall and Devon. (Standard)

Sartén (Mex.). A pan for drying moisture samples; frying pan. (Dwight)

Sassolite. Boric acid $B(OH)_3$ (Dana). Also spelled Sassolin; Sassoline.

Satelite. The gem-trade name for a fibrous serpentine having a chatoyant effect. (U. S. Geol. Surv.)

Satin spar. A fibrous silky variety of aragonite or of gypsum. (Power)

Satin stone. Same as Satin spar. (Standard)

Saturnine amaurosis. Impairment of vision from lead poisoning. (Standard)

Saturnine breath. The peculiar odor in the breath of one affected with lead-poisoning. (Standard)

Saturnine colic. Lead colic. (Standard)

Saturnine palsy. Lead palsy. (Standard)

Saturnism. Lead poisoning. (Standard)

Saussurite. A tough, compact, white, greenish, or grayish mineral, produced in part at least, by the alteration of feldspar, and consisting chiefly of zoisite or epidote. (Webster)

Saussuritization. The process by which saussurite is formed. (Standard)

Savelsberg process. *See* Blast roasting.

Saw (Eng.). A tool for removing irregularities from the sides of boreholes. (Gresley)

Sawback. A mountain range having sharp peaks of about equal height; a sierra. (Webster)

Saw gang. A frame provided with a number of parallel iron bars which are employed to saw stone (Bowles). *See* Stone-saw.

Sawney (Mid.). To lower full trams down a road with a rope or chain passing round a prop, etc. (Gresley)

Sawtooth back stoping. *See* Overhand stoping.

Saw-tooth floor channeling. A method of channeling inclined beds of marble by removing right-angle blocks in succession from the various beds, thus giving the floor a zigzag or saw-tooth appearance. (Bowles)

Saw-tooth stoping. *See* Rill stoping.

Sax. A slate-cutter's hammer, having a pointed pick at the back to make nail-holes. Called also Slate-ax. (Standard)

Saxatile. Pertaining to rocks. (Saxicolene. (Webster)

Saxonian chrysolite. A pale wine-yellow topaz. (Power)

Saxonite. A variety of peridotite containing essential olivine and orthorhombic pyroxene, with or without biotite, hornblende, chromite, and picotite. (La Forge) It is a synonym for Harzburgite, but saxonite has priority. (Kemp)

Scab. 1. (Iowa). To dress, with heavy picks or hammers, rough quarry material to approximately rectangular blocks. *See* Scabble, 1. 2. In founding, a blister or swell on the surface of a casting. (Standard)

Scabbit parting (Scot.). A rough parting. (Barrowman)

Scabble. 1. To work or shape roughly, as a stone before leaving a quarry. 2. To dress in any way short of fine tooling or rubbing, as stone (Webster). *Compare* Scab, 1.

Scabbler. In granite works, a workman who scabbles. (Century)

Scabbling. 1. The process of removing all surface irregularities from blocks of stone and thus reducing them to proper form. (Bowles) *See* Scab, 1.
2. A fragment or chip of stone. (Webster)

Scabbling hammer. A hammer with two pointed ends for picking the stone, after the spalling hammer. (Century)

Scabby. In founding, blistered or marred with scabs; said of a casting. (Standard)

Scad. A name occasionally applied to a nugget, as of gold. (Duryee)

Scaf (Prov.). The tapered edge of metal where two pieces are welded together. (Standard)

Scaffings (Derb.). Refuse from ore dressing; chippings. (Hooson)

Scaffold. An obstruction in a blast furnace above the tuyères caused by an accumulation or shelf of pasty, unreduced materials adhering to the lining. (Raymond)

Scaffolding. Incrustations on the inside of a blast furnace (C. and M. M. P.). *See* Scaffold.

Scaglia. An Italian calcareous somewhat fissile and fossiliferous Cretaceous rock, corresponding to the Chalk of England. (Standard)

Scagliola (It.). Hard, polished plaster-work imitating marble, granite, or other veined, mottled, or colored stone: made of powdered gypsum and glue or isinglass, colored and variegated in various ways. (Standard)

Scal (Corn.). *See* Scall.

Scale. 1. The crust of metallic oxide formed by cooling of hot metals in air. Hammer-scale and roll-scale are the flaky oxides which fall from the bloom ingot, or bar under hammering or rolling. 2. The incrustation caused in steam-boilers by the evaporation of water containing mineral salts. 3. (Newc.) A small portion of air abstracted from the main current. Also called Scale of air, and sometimes spelled Skail. (Raymond)
4. The rate of wages to be paid, which varies under certain contingencies. (Steel)
5. Crude paraffin obtained in petroleum refining by filtering from the heavier oils. (Webster)
6. Loose, thin fragments of rock, threatening to break or fall from either roof or wall. (Morine)
7. To get rid of the film of oxide formed on the surface of a metal, as to clean the surface.

Scale copper. Copper in very thin flakes. (Weed)

Scalent. In the Pennsylvania (Roger's) system of stratigraphy, a group considered equivalent to the Lower Helderberg of the New York Survey. (Standard).

Scale of air (Newc.). *See* Scale, 3.

Scale stone. Same as Wollastonite. (Standard)

Scaling bar. A bar-like implement for removing incrustations as from the inside surfaces of boilers. (Standard)

Scaling furnace. A furnace or oven in which plates of iron are heated for the purpose of scaling them, as in the preparation of plates for tinning. (Century)

Scall. 1. (Eng.). Loose ground; foliated ground is frequently called *scally* ground by miners (Hunt). Also spelled Scal. Probably a variation of scale.
2. Rock easily broken up because of its scaly structure. (Standard)

Scallop (Eng.). To cut or break off the sides of a heading without holing or using powder. (Gresley)

Scammed (No. of Eng.). Sooty. (Gresley)

Scamy (Eng.). Applied to freestone in thin layers, mixed with mica. (Bainbridge)

Scamy post (No. of Eng.). Soft, short, jointy freestone, thinly laminated and much mixed with mica. (Gresley)

Scandium. A rare metallic trivalent element found combined in company with yttrium, cerium, etc. The element has not been isolated. Symbol, Sc; atomic weight, 44.1. (Webster)

Scantite. A gauge by which slates are assorted in sizes. (Standard)

Scantling. The dimensions of a stone in length, breadth, and thickness. (Standard)

Scapolite. The group name for certain orthosilicates. For common scapolite, *see* Wernerite. (Dana)

Scapolite-gabbro. A massive, hornblende scapolite rock formed by the alteration of gabbro. Called also Spotted gabbro. (Standard)

Scar. 1. (Scot.) An isolated or protruding rock; a steep, rocky eminence; a bare place on the side of a mountain or steep bank of earth.
2. (Eng.) In roasting pyrite for sulphuric acid manufacture, a lump formed by fritting; a hard cinder; furnace slag. (Webster)
3. In founding, an imperfect spot in a casting. (Standard)

Scarcement. 1. A projecting ledge of rock, left in a shaft as footing for a ladder, or to support pit-work, etc. (Raymond)
2. An offset or retreat in the thickness of a wall or band of earth, etc. (Webster)

Scares (No. of Eng.). Thin laminæ of pyrite in coal. (Gresley)

Scarf. 1. A lapped joint made by beveling, notching, or otherwise cutting away the sides of two timbers at the ends, and bolting or strapping them together so as to form one continuous piece, usually without increased thickness. Called also Scarf joint. 2. A piece of metal shaped or beveled for a scarf weld. (Standard)

Scarfing. Splicing timbers, so cut that when joined the resulting piece is not thicker at the joint than elsewhere. (Raymond)

Scarf joint. *See* Scarf, 1.

Scarf weld. A weld-joint between two metal pieces that are notched or beveled. (Standard)

Scar limestone. The mountain limestone of the English Lower Carboniferous: so called because it frequently forms scars or cliffs. Called also Scaur limestone; Thick limestone. (Standard)

Scarp. 1. An escarpment, cliff, or steep slope along the margin of a plateau, mesa, terrace, or bench. The term implies a certain amount of linearity and should not be used for a cliff or slope of highly irregular outline. (La Forge) 2. To cut down vertically, or nearly so; as, to scarp a ditch. (Webster)

Scarring. 1. The formation of scars or scaurs in roasting pyrite for sulphuric acid manufacture. (Webster). *See* Scar, 2.
2. A mark left by abrasion, or such marks collectively; said specifically of geological processes; as, the *scarrings* of the glacier. (Standard)

Scatter (York.). A rumbling or falling noise in a mine-shaft. (Gresley)

Scaur (Scot.). *See* Scar.

Schalstein. An old name for a more or less metamorphosed diabase tuff. (Kemp)

Schapbachite. A lead-bismuth mineral, $PbS.Ag_2S.Bi_2S_3$ occurring in acicular crystals, granular and massive. Color lead-gray (Dana). Called also Bismuth silver.

Schaum earth. Same as Aphrite.

Scheelite. Calcium tungstate, $CaWO_4$. Contains 80.6 per cent tungsten trioxide, WO_3. (U. S. Geol. Surv.)

Scheererite. A whitish, gray, yellow, green, or pale reddish, brittle, tasteless, inodorous hydrocarbon; it melts at 44° C. and is soluble in alcohol and ether. It may be distilled without decomposition, boiling at 92° C. (Bacon)

Schefferite. A brown to black variety of pyroxene, containing manganese and frequently much iron. (Webster)

Schiefer spar. A variety of calcite occurring in very thin plates or scales. (Power)

Schiller. A bronze-like luster or iridescence due to internal reflection in minerals that have undergone schillerization. (Standard)

Schiller-fels. Enstatite, or bronzite-peridotite with poicilitic pyroxenes. Orthorhombic pyroxenes possess the poicilitic texture to a peculiar degree, and especially when more or less altered to bastite, the term schiller is especially applied to them. (Kemp)

Schillerization. The development of poicilitic texture by the formation of inclusions and cavities along particular crystal planes, largely by solution, somewhat as are etch figures.

Schiller spar. An altered enstatite or bronzite, having approximately the composition of serpentine. Bastite. (Dana)

Schist. A crystalline rock that can be readily split or cleaved because of having a foliated or parallel structure, generally secondary and developed by shearing and recrystallization under pressure. (La Forge)

Schistose. Characteristic of, resembling, pertaining to, or having the nature of schist. (La Forge)

Schistosity. The quality of being schistose; schistose structure; secondary foliation. (Standard)

Schlich (Ger.). Finely pulverized ore; mud (Whitney). Called also Slick.

Schlicker (Ger.). The skimmings from molten unrefined lead, containing chiefly copper, iron, and zinc, with a little antimony and arsenic. (Raymond)

Schliere (Ger.). An irregular portion, ordinarily not everywhere sharply bounded, of an igneous rock, that differs in texture or composition from the rest of the mass but is an essential part of it. Plural, Schlieren. (La Forge) There are several different varieties, for discussion of which *see* Zirkel's Lehrbuch der Petrographie, I., 787, 1893. (Kemp)

Schmelze. Any one of various kinds of decorative glass, especially the variety that is colored red with a metallic salt, as copper or gold, and used to flash white glass. (Standard)

Schneider furnace. A distillation furnace for the reduction of zinc ores containing lead, with a recovery of the latter metal as well as the zinc. (Ingalls, p. 491)

Schorl. An old name for tourmaline, still sometimes used in names of rocks. (Kemp) Mainly restricted to black tourmaline.

Schorlaceous. Containing black tourmaline; as *schorlaceous* granite. (Standard)

Schorlomite. A massive, black silicate of titanium, iron and calcium. (Century)

Schraufite. A resin, $C_{11}H_{16}O_2$, which occurs in Carpathian sandstone near Wamma, in Bukowina. It has a specific gravity of 1.0 to 1.12 and fuses at 326° C. (Bacon)

Schungite. An amorphous form of carbon that is closely related to graphite. (Standard)

Schwefelkies; Eisenkies (Ger.). Pyrite. (Dana)

Schwerspath (Ger.). Barite. (Dana)

Scintillation. Burning with brilliant sparks; *e. g.*, white-hot iron when exposed to a current of air. (Jackson)

Scintle. To stack molded bricks with places between to allow ventilation for drying. (Webster)

Scintling. A scintled brick, or one ready to be scintled. (Standard)

Scissors fault. A fault of dislocation, in which two beds are thrown so as to cross each other. (C. and M. M. P.)

Sclaffery (Scot.). Liable to break off in thin fragments, as the roof of a mine working. (Barrowman)

Scleretinite. A black, brilliant oxygenated hydrocarbon from the coal measure of Wigan, England; it has a specific gravity of 1.136, and is insoluble in alcohol, ether, alkalies and dilute acids. (Bacon)

Sclerometer. An instrument for determining the degree of hardness of a mineral by ascertaining the pressure on a moving diamond point necessary to effect a scratch. (Standard)

Scliit; Sclutt (Scot.). Coaly blaes, or slaty coal. (Barrowman)

Scobbed (Scot.). Said of a car only partly filled with coal. A hutch of mineral is scobbed when large pieces are laid over the corners to give the appearance of the hutch being full, when there is in reality little material in it. (Barrowman)

Scobs. The dross of metals. (Standard)

Scolecite. A vitreous or silky, transparent to subtranslucent, hydrous calcium-aluminum silicate, $CaAl_2Si_3O_{10}+3H_2O$. (Dana)

Scomfish (No. of Eng., and Scot.). To suffocate, as with foul gas or smoke; smother; stifle. (Standard)

Sconce. A protection, cover, shelter, or screen (Webster). A metal cover and holder combined for holding a miner's candle, especially for hanging on wooden timbers.

Scoop (York.) A barrel or box used in a gin pit. (Gresley)

Score 1. (No. of Eng.) A standard number of tubs of coal upon which hewers' and putters' prices for working are paid. 2. A bill run up by a collier in "bad times" for the necessaries of life. (Gresley)
3. To mark with scratches or furrows, as rocks in certain localities by glacial drift. 4. To burst or split from unequal cooling: said of a casting. (Standard)

Scoria. 1. An irregular, rough, clinkerlike, more or less vesicular fragment of lava, thrown out in an explosive eruption or formed by the breaking up of the first-cooled crust of a lava flow. Plural, Scoriae. (La Forge)
2. Refuse of fused metals; dross; slag. (Standard)

Scoriaceous. Characteristic of, pertaining to, consisting of, or resembling scoriae; having a rough, irregular, clinkerlike, somewhat vesicular surface; said of some lava. (La Forge)

Scorification. A process employed in assaying gold and silver ores, and performed in a shallow clay vessel (scorifier), in which ore, lead, and borax-glass are exposed to heat and oxidation in a muffle. The operation involves roasting, fusion, and scorification proper, or the formation of a slag, which is not, like the litharge produced in cupellation, absorbed by the vessel. (Raymond)

Scorifier. 1. A small bowl-shaped cup used in assaying. 2. A furnace in which sweepings containing waste gold or silver are burnt, preparatory to extracting the gold and silver. (Webster)

Scoring. A deep groove or such grooves collectively, as those made by glacial action. (Standard)

Scorodite. Hydrous ferrous arsenate, $Fe_2O_3.As_2O_5.4H_2O$. (U. S. Geol. Surv.)

Scotch. 1. A wooden stop-block or iron catch placed across or between the rails of underground roadways, to keep the tubs from running loose, or to hold them when standing upon an inclined plane. 2. (Leic.) The lower lift of coal which is wedged up in driving a heading. (Gresley)
3. A chock, wedge, prop, or other support to prevent slipping or rolling. (Webster)
4. To dress, as stone, with a pick or picking tool. 5. A slotted bar used to hold up well-boring rods during adjustment. (Standard)

Scotch gauze-lamp (Scot.). A safety lamp used in Scotland, the top of the lamp being wholly of wire gauze. (Barrowman)

Scotch hearth. A low forge or furnace of cast-iron, with one tuyère, in which rich galena is treated by a sort of accelerated roasting and reaction process. (Raymond)

Scotching. A method of dressing stones either with a pick or pick-shaped chisels. (Century)

Scotch pebble. One of several varieties of quartz, chiefly cairngorm, used in Scotland as a semiprecious stone. (Standard)

Scotch pig. A very pure grade of pig iron. (Standard)

Scotch stone. *See* Ayr stone.

Scour (Mid.). To excavate or brush a roadway through a goaf. (Gresley)

Scouring. Having the quality of eroding the furnace-hearth, as some kinds of slag or cinder (Standard). *See* Scouring cinder.

Scouring bit (Eng.). A piece of iron at the end of the boring rod for extracting drill cuttings. (Bainbridge)

Scouring cinder. A basic slag, which attacks the lining of a shaft furnace. (Raymond)

Scourway. A drainage furrow caused by a strong current, as by a glacial river flowing over a gravel plain. (Standard)

Scout. A term frequently used for an engineer who makes preliminary examinations of promising mining claims and prospects, as for mineral, coal, oil, etc.

Scouter (Prov.). In stone-working, a quarryman whose function is to split off large portions of rock by means of a jump drill and wedges. (Standard)

Scovan (Corn.). A tin-bearing lode.

Scovan lode (Corn.). A lode of tin, especially one showing no gossan. (Webster)

Scovany. Like a tin lode; hard to work, by reason of the absence of selvage or other soft material. (Standard)

Scove. 1. (Corn.) Rich, clean tin ore. (Webster)
2. To case up (bricks) in a kiln. (Standard)

Scove kiln. A temporary kiln, often used for burning common brick. (Ries)

Scovens (So. Staff.). Forks for loading coal into tubs, or cars. (Gresley)

Scovillite. A hydrous phosphate of didymium, yttrium, and other rare earths. (Century)

Scoving. The outer wall or casing of a brickkiln. (Standard)

Scowl (Local Eng.). Old workings at the outcrop of deposits of iron ore; a term peculiar to the Forest of Dean. (Standard)

Scowl a brow (Forest of Dean). To drive a heading or level by guesswork. (Gresley)

Scram. 1. To search for and extract ore in a mine that is apparently worked out. (Weed)
2. (Ala.) A small soft-coal mine complete in itself. (Republic Steel & Iron Co. *v.* Luster, 68 Southern, p. 359, -1915)

Scrammer. One who scrams (Standard). *See* Scram, 1.

Scram pile (Prov.). The product of the scrammers' labors, gathered for shipment (Standard). *See* Scram, 1.

Scraper. 1. A tool for cleaning the dust out of the bore-hole. 2. A mechanical contrivance used at collieries to scrape the culm or slack along a trough to the place of deposit. 3. One who separates the ores from the waste rock. (Steel)
4. An apparatus drawn by horses or oxen for scraping up earth in making roads or canals, and for removing overburden from shallow coal beds and mineral deposits.

Scraper chaser (Oil regions, U. S.). One of a number of men whose business it is to follow the scraper (go-devil) in the petroleum pipes and give instant notice if a clog occurs (Standard). He follows the pipe line on the surface and detects the location of the go-devil by sound, especially where pipes are shallow. *See* Go-devil, 1.

Scraper conveyer. A mechanical device for conveying coal, rock, ashes, culm, etc., in a metal trough by means of scrapers attached to a rope or chain.

Scrap-forgings. Forgings formed from wrought-iron scrap. (Standard)

Scrapman. *See* Scrapper. May also refer to a man who breaks and removes heavy scrap in cast houses at blast furnaces. (Willcox)

Scrapper. 1. One who removes scrap from bin, cast house, or chute to skip pit, and charges the material removed into a skip at regular intervals. (Willcox)
2. A local name given to men who pick up the ore left on dumps. (C. and M. M. P.)

Scrap picker. A man employed on the slag dump to pick out pieces of iron carried to the dump in slag ladles. (Willcox)

Scrapping. The breaking up of metal castings, plate, etc., with explosives, generally by mudcapping. (Du Pont)

Scratch. A calcacerous, earthy, or strong substance which separates from sea water in boiling it for salt. (Century)

Scratched. In ceramics, ornamented with rough scratches in the paste. (Standard)

Scratcher (Eng.). A boring tool for loosening (or scratching) the cuttings at the bottom of a bore-hole, to be afterwards removed by a mizer. (Gresley)

Scratch pan. A pan in salt works to receive the scratch. (Century)

Scree. 1. A heap of rock waste at the base of a cliff, or a sheet of waste covering a slope below a cliff; same as Talus, *which see.* (La Forge)
2. A sieve, screen, or strainer (Webster). A coal screen.

Scree bars (Scot.). Bars of which a scree is constructed (Barrowman). *See* Scree, 2.

Screen. 1. A sieve of wire cloth, grate-bars, or perforated sheet-iron used to sort ore and coal according to size. Stamp-mortars have screens on one or both sides, to determine the fineness of the escaping pulp. (Raymond)
2. A cloth brattice or curtain hung across a road in a mine to direct the ventilation. (Gresley)
3. (Joplin, Mo.) A grizzly near the top of a head-frame.

Screen analysis. The determination of weights of crushed material which passes through or is held on a series of screens of varying mesh. (Clennell)

Screen ape (Joplin, Mo.). One who attends the grizzly, or screen. He breaks the large pieces of ore, and picks out such waste rock as he can as it passes over the screen.

Screen cloth (Scot.). Tarred canvas; brattice cloth. (Barrowman)

Screened coal. 1. Coal that has passed over any kind of a screen and therefore consists of the marketable sizes.
2. Specifically, coal that is weighed and credited to the miner after passing over a standard screen. (Steel)

Screening machine. An apparatus having a shaking, oscillatory, or rotary motion, used for screening or sifting coal, stamped ores, and the like.

Screener (Newc.). A man who shovels the coal from the screens into the wagons. (Min. Jour.)

Screenings. Fine coal that passes through a screen when screening for lump coal.

Scree plate (Scot.). An iron plate at the foot of a screen on which screened coal is discharged. (Barrowman)

Screw bell. A recovering tool in deep boring, ending below in a hollow screw-threaded cone. (Raymond)

Screw casing. A threaded lap-welded well casing. (Redwood, p. 206)

Screw-down. A workman in a rolling mill whose duty it is to judge of the distance to be given between rolls at each pass and to adjust them correspondingly. (Standard)

Scribe. An instrument used by surveyors for marking posts, trees, etc.

Scrin. 1. (Derb.) Ironstone in irregular-shaped nodules. (Gresley)
2. (Derb.) A small subordinate vein (Raymond). Also spelled skrin.

Scrip. Credit slips or tickets issued by a mining company to its employees before pay day in lieu of cash. The scrip drawn is charged against the pay of the employee, and is exchangeable for commodities at the company store at its face value.

Scroddle. To variegate, as pottery ware, in different colors by the use of various colored clays. (Standard)

Scroll drum (Eng.). A conical winding drum. (Gresley)

Scronge (So. Wales). Overlying strata loosened or broken by workings underneath (Gresley). Probably a variation of scrunge, to squeeze.

Scrowl. 1. (Corn.) A thin, sometimes calcareous, sometimes siliceous, rock attached to the wall of a lode. (Power)
2. (Corn.) Loose ore at the point where a lode is disturbed by a cross vein. (Davies)

Scrubber. An apparatus for washing coal gas, or other gases. (Webster)

Scrubstone (Eng.). A provincial term for a variety of calciferous sandstone. (Humble)

Scrub water (Ark.). Water supplied to mining camps for bathing and laundry purposes. (Steel)

Scud. 1. (Leic.) Very thin layers of soft matter, such as clay, sooty coal, etc. 2. (Mid.) Pyrite embedded in coal seams. (Gresley)

Sculp. To break slate into slabs suitable for splitting. (Webster)

Scum. Impure or extraneous matter that rises or collects at the surface of liquids, as vegetation on stagnant water, or dross on a bath of molten metal. Sometimes, but incorrectly, used for the word "froth" in flotation. (Rickard)

Scun (Devon.). A small vein. (Davies)

Scupper nails. Nails with broad heads, for nailing down canvas, etc. (C. and M. M. P.)

Scyelite. Judd's name for a rock, related to the peridotites, that occurs near Loch Skye, in Scotland. Its principal mineral is green hornblende, presumably secondary after

augite; with it are bleached biotites and serpentine, supposed to be derived from olivine. (Kemp)

Scythestone. A whetstone suitable for sharpening scythes. (U. S. Geol. Surv.)

Sea-beach placers (Alaska). Placers adjacent to the seashore to which the waves have access.

Se abre (Sp.). A miner's phrase for the widening or opening of a vein. (Halse)

Sea coal. 1. (Scot.) Coal, which in early times was worked on the sea shore; coal carried by sea; coal seaward of low-water mark belonging to the Crown (Barrowman). Formerly so called in distinction from charcoal, because originally brought to London by sea. (Webster)
2. (Rare U. S.) Soft coal, as distinguished from anthracite. (Standard)
3. A finely ground coal used as a powder for facing molds; foundry facing.

Seafoam. An early synonym for Meerschaum. (Chester)

Seal. 1. (Corn.) A portion of earth or rock which separates and falls from the main body. (Raymond)
2. To secure against a flow or escape of gas, air, or liquid; as to seal a mine.

Seal coat. A final superficial application of bituminous material to a pavement upon completion of construction. (Bacon)

Seam. 1. A stratum or bed of coal or other mineral. 2. (Corn.) A horseload. 3. A joint, cleft, or fissure. (Raymond)
4. A plane in a coal bed at which the different layers of coal are easily separated. (Steel)
5. A ridge in a casting, marking the place where the mold parted. (Standard)

Seam blast. A blast made by placing powder or other explosives along and in a seam or crack between the solid wall and the stone or coal intended to be removed. (Barclay *v.* Wetmore-Morse Granite Co. (Vt.), 102 Atlantic, 495)

Seam-out. A shot that merely blows out a soft stratum in the coal or escapes through a seam without loosening the main mass of coal. In Arkansas, called Squeal out. (Steel)

Sea mud. A rich saline deposit from salt marshes and seashores. (Century)

Seamy. Full of seams so as to be difficult to blast. (Steel)

Sea ore (Eng.). Sea weed. (Webster)

Seasale (Newc.). Coal delivered by or to ships, as for export. (Min. Jour.)

Sea salt. Salt made by the evaporation of sea water. (Standard)

Seasoned. Applied to quarry stone after the moisture has dried out. (Gillette, p. 6)

Seat. 1. (Derb.) The floor of a mine. (Raymond)
2. The foundation or framework on which a structure rests, *e. g.*, engine seat, cage seat. (Barrowman)

Seat-clay. Fire clay. (Power)

Seat earth (York.). A bed of clay underlying a coal-seam; sometimes highly siliceous, and then known as *ganister*. Called also Underclay. (Standard)

Seat rock; Hard seat. The nearest bed of clunch, grit, or sandstone, under a coal seam (Power). Also called Seat stone.

Seat stone. *See* Seat rock.

Sea wax. A kind of ozocerite or mineral wax; maltha. (Webster)

Sebka (No. Afr.). A dry area or bed of a lake incrusted with salt; a salt marsh. (Standard)

Secador (Mex.). An apparatus for drying samples. (Halse)

Secadora (Colom.). A copper vessel for drying gold before weighing. (Halse)

Secas (Mex.). Refined silver. (Halse)

Sección (Sp.). Section. (Dwight)

Se cierra (Sp.). A miner's phrase for the narrowing or closing of a vein. (Halse)

Seco. 1. (Sp.) Dry. In the *patio* process, said of gangue which is dry. 2. *Veta seca* (Colom.), a vein lacking water for its exploitation. (Halse)

Second, or Back explosion (Aust.). Supposed to be due to the ignition of gases developed from highly heated coal dust, and gases sucked out of the faces of coal by the partial vacuum resulting from the primary explosion, or liberated by fall of roof (Power). *Compare* Retonation wave.

Secondary. 1. (a) Having been acquired or formed by alteration or metamorphism since the formation of the rock; derived; said of some textures and minerals of altered rocks and contrasted with "original." (b) Formed of material derived from the erosion or disintegration of other rocks; derivative: said of clastic sedimentary rocks. 2. Same as Mesozoic, which has replaced it. Obsolescent in this sense. (La Forge)

Secondary blasting. A term applied to the blasts employed in breaking up the larger masses of rock resulting from the primary blasts. Also termed Blistering or Bulldozing. (Bowles)

Secondary clay. Clay found deposited away from its place of formation. (Webster)

Secondary drilling. The process of drilling the so-called "pop holes" for the purpose of breaking the larger masses of rock thrown down by the primary blast. (Bowles)

Secondary enlargement. The addition of silica to the original quartz grains of a sandstone, the secondary or added part having the same optical orientation as the original grain. It may result in the development of crystal faces. (Bowles)

Secondary enrichment. An enrichment of a vein or an ore body by material of later origin, often derived from the oxidation of decomposed overlying ore masses. Nature's process of making high-grade out of low-grade ores. First discovered by Weed and announced by publication in Geol. Soc. of America program, Dec. 8, 1899. Confirmed by Emmons and by Van Hise, Feb., 1900. (Weed)

Secondary mineral. A mineral resulting from the alteration of a primary mineral. Thus, original sulphides by oxidation change to sulphates, carbonates, and oxides, and these by hydration become hydrous forms of the same.

Second outlet; Second opening. An auxiliary passageway out of a mine, for use in case of accident to the main outlet. (C. and M. M. P.)

Seconds. The second-class ore of a mine that requires dressing. (C. and M. M. P.)

Second working. The operation of getting or working out the coal pillars formed by the first working. (Gresley)

Section. 1. In geology, either a natural or an artificial rock-cut, or the representation of such on paper. (Roy. Com.)
2. A term usually applied to a vertical exposure of strata. 3. A drawing or diagram of the strata sunk through in a shaft or inclined plane, or proved by boring. (Gresley)
4. (Scot.). A division of the mine workings. (Barrowman)
5. One of the portions, of 1 mile square, into which the public lands of the United States are divided and containing 640 acres. One thirty-sixth of a township. (Webster)
6. A very thin slice of anything, especially for microscopic examination. (Specifically, rocks, steels, alloys, etc.) 7. The local series of beds constituting a group or formation, as, the Cambrian *section* of Wales. (Standard)

Sedentary. Formed in place, without transportation, by the disintegration of the underlying rock or by the accumulation of organic material; said of some soils, etc. (La Forge)

Sediment. 1. Unconsolidated, clastic, rock-forming material, deposited, commonly in layers of strata, from suspension in or transportation by water or air. (La Forge)
2. In a steam-boiler, an internal deposit of loose soft matter, as distinguished from *scale*, which is hard. (Standard)

Sedimentary. Formed by deposition or accretion of grains or fragments of rock-making material, commonly from suspension in or transportation by water or air, or by the precipitation of such material from solution, with or without the aid of living organisms: said of one of the two great classes of rocks and contrasted with Igneous. (La Forge)

Sedimentary rocks. Rocks formed by the accumulation of sediment in water (aqueous deposits) or from air (eolian deposits). The sediment may consist of rock fragments or particles of various sizes (conglomerate, sandstone, shale); of the remains or products of animals or plants (certain limestones and coal); of the product of chemical action or of evaporation (salt, gypsum, etc.); or of mixtures of these materials. Some sedimentary deposits (tuffs) are composed of fragments blown from volcanoes and deposited on land or in water. A characteristic feature of sedimen-

tary deposits is a layered structure known as bedding or stratification. Each layer is a bed or stratum. Sedimentary beds as deposited lie flat or nearly flat. (Ransome)

Sedimentation. The accumulation of earthy particles, usually under water. A sedimentary rock is one consisting of particles thus deposited. (Perkins)

Sedimento (Sp.). Sediment; boiler scale. (Halse)

Sediment vein. A fissure filled from above by sedimentary matter. A rare occurrence in nature. (Shamel, p. 165)

Seed-bag. A bag filled with flaxseed and fastened around the tubing in an artesian well, so as to form, by the swelling of the flaxseed when wet, a water-tight packing, preventing percolation down the sides of the bore hole from upper to lower strata. When the tubing is pulled up the upper fastening of the bag breaks, and it empties itself, thus presenting no resistance to the extraction of the tubing. (Raymond)

Seep. A spot where water or petroleum oozes out slowly; a small spring. (Webster)

Seepage. A fluid, or the quantity of it, that has oozed or seeped through porous soil. (Webster)

Segger; Sagger. A cylindrical vessel of fire-clay in which fine stoneware is encased while being baked in the kiln. (Ure)

Segregate. 1. (Pac.) To separate the undivided joint ownership of a mining claim into smaller individual "segregated" claims. (Raymond) 2. In geology, to separate from the general mass, and collect or become concentrated at a particular place or in a certain region, as in the process of crystallization and solidification (Webster). *See* Segregated vein.

Segregated vein. A vein in which the filling is believed to have been derived from the adjacent country rock by percolating water carrying the dissolved mineral matter into the fissure. (Shamel, p. 149)

Segregation survey. The survey of a mining claim located on lands classified as agricultural. (Creswell Min. Co. *v.* Johnson, 8 Land Decisions, p. 442; Lannon *v.* Pinkston, 9 Land Decisions, p. 143)

Segregation vein. Same as Segregated vein.

Segullo (Sp.). Earth overlying auriferous deposits. (Lucas)

Seismic. Pertaining to, characteristic of, or produced by earthquakes or earth-vibration; as, *seismic* disturbances. (Standard)

Seismic area. The area affected by any particular earthquake. (Standard)

Seismism. The processes or phenomena involved in earth movements. (Standard)

Seismology. The science of earthquakes. (Power)

Seismoscope; Seismometer. An instrument by the aid of which the data are obtained for the scientific study of earthquake phenomena. (Century)

Selagite. A name of Hauy's for a rock consisting of mica, disseminated through an intimate mixture of amphibole and feldspar, but it has been since applied to so many different rocks as to be valueless. (Kemp)

Selective flotation. Generally understood to refer to the surface or froth "selecting" the valuable minerals rather than the gangue. Sometimes used to mean Differential flotation, which *see*. Also *see*. Preferential flotation. (O. C. Ralston, Bu. Mines)

Selective mining. A method of mining whereby ore of unwarranted high value is mined in such manner as to make the low-grade ore left in the mine incapable of future profitable extraction. In other words, the best ore is selected in order to make good mill returns, leaving the low-grade ore in the mine. Frequently called Robbing a mine.

Selector. In copper smelting, a kind of converter with horizontal tuyères, to produce bottoms and a purified copper in one operation. (Webster)

Selenite. Gypsum in distinct crystals or broad folia, $CaSO_4.2H_2O$. *See* Gypsum. (U. S. Geol. Surv.)

Selenite plate. In mineralogy, a plate of selenite which gives a purplish-red interference color of the first order with crossed nicols. (A. F. Rogers)

Selenium. An element, Se. Not found native in visible quantity. Is obtained as a by-product in the electrolytic refining of copper. *See* Ono-

frite and Tiemmanite (U. S. Geol. Surv.). Resembles sulphur and tellurium chemically. Atomic weight, 79.2; specific gravity, 4.26.

Selenolite. Wadsworth's name for rocks composed of gypsum or anhydrite. (Kemp)

Self-acting plane. An inclined plane upon which the weight or force of gravity acting on the full cars is sufficient to overcome the resistance of the empties; in other words, the full car, running down, pulls the other car (empty) up. (Steel)

Self-contained portable electric lamps. Electric lamps that are operated by an electric battery that is designed to be carried about by the user of the lamp. (H. H. Clark)

Self-detaching hook. A self-acting hook for setting free a hoisting rope in case of overwinding. (C. and M. M. P.)

Self-feeder. An automatic appliance for feeding ore to stamps or crushers without the employment of hand labor. (Min. Jour.)

Self-glazed. Having a glaze of but one tint: said of Oriental porcelain. (Standard)

Self-open (Derb.). A natural fissure in rock. Also called Shack. (Mander)

Self-shooter. *See* Booming; *also* Flopgate.

Selvage; Selfedge. A layer of clay or decomposed rock along a vein-wall. *See* Gouge. (Raymond)

Semialtos (Mex.). Furnaces of medium size for smelting copper ores. (Halse)

Semi-bituminous. Half or somewhat bituminous; applied to a variety of coal intermediate between bituminous coal and anthracite, averaging 15 to 20 per cent of volatile matter. (Webster)

Semi-crystalline. Somewhat crystalline; said of rocks that are partly crystalline or partly amorphous. (Standard)

Semi-dry-press process. In brick making, practically the same as dry press, but clay may be slightly moister. (Ries)

Semi-faïence. Pottery with a glaze very thin or transparent. (Webster)

Semi-metal. In old chemistry, a metal that is not malleable, as bismuth, arsenic, antimony, etc. (Century) Long obsolete.

Semi-opal. Common opal as distinguished from precious and fire opal. (A. F. Rogers)

Semi-porcelain. A kind of porcelain resembling earthenware in its lack of translucency or interior finish. (Webster)

Semi-precious. Precious in an inferior degree; applied especially to such stones as amethyst, garnet, tourmaline. (Webster)

Semi-steel. A mixture consisting of ⅔ No. 1 charcoal iron and ⅓ of varying proportions of good wrought-iron scrap, soft-steel punchings, shearings or rail butts. Used for making slag pots (Hoffman, p. 259). Puddled steel.

Semi-transparent. A term used to describe minerals when objects may be seen through them but without distinct outlines. (Dana)

Semi-water-gas. A fuel gas intermediate in composition between water-gas and producer-gas, made by allowing a mixture of steam and air to flow into a producer. (Webster)

Semi-wet method. A method of mixing the raw materials for Portland cement. The materials at first are dry; at some stage water is added, all subsequent steps being similar to those employed in the wet method (Bowles). Also termed Semi-dry method.

Sempatic. A descriptive term applied to porphyritic igneous rocks to indicate that the total volumes of phenocrysts and groundmass are nearly equal. (Ransome)

Señalamiento (Sp.). Marking on the surface the position of underground workings. (Halse)

Señalar (Sp.). 1. To mark out (mining) claims. 2. To signal. (Halse)

Senarmontite. Antimony trioxide, Sb_2O_3, in pearl colored isometric octahedra. *See* Valentinite. (Moses)

Seneca oil (U. S.). Petroleum, early used as a remedy among the Senecas and other Indians. (Webster)

Senile. Approaching the end of a cycle of erosion, as a senile topography. (Webster) *See* Old.

Senile river. In geology, a river in its later stage, rarely fully reached, characterized by a sluggish current having a tendency to meander through a pene-plane of slight relief in faint grades above base level, providing a slow discharge of rainfalls. (Standard)

Senile stream. A stream whose current has become enfeebled by reason of an approximation of its valley to base-level (Standard). *Compare* Senile river.

Senile topography. The physical aspect or conformation of land which approximates to a base-level plain. (Standard)

Senonian series. A division of the Upper Cretaceous of France and Belgium, used also somewhat in England; equivalent to the Upper Chalk of England. (Standard)

Señorial (Peru). Royalty paid by *busconeros* to the owners of reverberatory furnaces. (Halse)

Sensitiveness. The property in a high explosive that permits it to be exploded by a shock. The more insensitive an explosive is, the stronger detonator it requires to develop the full strength. (Du Pont)

Sentazón (Arg.). A slide or fall of rock. (Halse)

Separable tin (Eng.). An incorrect spelling of Sparable. *See* Sparable tin.

Separar (Sp.). To separate, classify, or sort. (Halse)

Separation coal (Eng.). Coal that has been prepared by screening or washing.

Separation doors (Eng.). Doors fixed underground between the intake and the return, near the shaft bottom. (Gresley)

Separation valve (Eng.). A massive cast-iron plate suspended from the roof of a return airway, through which all the return air of a separate district flows, allowing the air to always flow past or underneath it; but in the event of an explosion of gas the force of the blast closes it against its frame or seating, and prevents a communication with other districts. The blast being over, the weight of the valve causes it to return to its normal position, allowing the ventilation to continue. (Gresley)

Separator. 1. A machine for separating, with the aid of water or air, materials of different specific gravity. Strictly, a separator parts two or more ingredients, both valuable, while a concentrator saves but one and rejects the rest; but the terms are often used interchangeably. 2. Any machine for separating materials, as the magnetic separator for separating magnetite from its gangue. (Raymond)
3. A screen, especially a revolving screen for separating things like stones or coal into sizes. (Standard)

Sepé (Colom.). A layer of porphyritic iron-stained clay above the pay dirt. (Halse)

Se pierde (Sp.). A miner's phrase, meaning the vein is lost or comes to an end. (Halse)

Sepiolite. *See* Meerschaum.

Septarium. A roughly spheroidal concretion, generally of limestone or clay-ironstone, cut into polyhedral blocks by radiating and intersecting cracks which have been filled (and the blocks cemented together) by veins of some material, generally calcite. Plural, Septaria. Also called Septarian bowlder, Septarian nodule, and Turtle stone. (La Forge)

Sequence. Following; succession; coming after; continuation. (Roy. Com.)

Serape (Mex.). A narrow blanket worn by miners, peónes, etc. (Halse)

Seriate. A rock fabric in which the sizes of the crystals vary gradually, or in a continuous series. (Iddings, Igneous Rocks, p. 196)

Sericite. A talc-like hydrous mica (a variety of muscovite) occurring in small scales and forming sericitic schist. Often spoken of by prospectors as talcose schist, but this latter term properly applies to schists composed largely of talc, which are much rarer. (Roy. Com.)

Sericite-gneiss. Gneiss containing sericite in the place of the ordinary more coarsely crystalline muscovite. (Century)

Sericite-schist. Mica-schist whose mica is sericite. Sericite is also used as a prefix to many names of metamorphic rocks containing the mineral. (Kemp)

Sericitization. The development of sericite in schists and other rocks, due to metamorphism.

Series. In geology, the stratigraphic subdivision of the third rank, in the classifications in general use; a division of a system. The chronologic term of equivalent rank is Epoch. (La Forge)

Series copper-refining process. *See* Hayden, Smith, and Randolph processes.

Serpentine. 1. In mineralogy, a hydrous magnesium silicate, $H_4Mg_3Si_2O_9$, commonly green, greenish-yellow, or greenish-gray, and massive, fibrous, lamellar, or occurring as pseudomorphs. It is an important constituent of some metamorphic rocks and is everywhere secondary, after olivine, amphibole, pyroxene, etc. 2. In petrology, a metamorphic rock composed chiefly or wholly of the mineral serpentine. (La Forge)

Serpentine marble. *See* Verd antique.

Serpentine ware. A hard, green-spotted or green-veined pottery suggestive of serpentine (Webster). A variety of Wedgwood ware. *See* Pebble ware.

Serpentization. Alteration into serpentine, a common result of the metamorphism of ferro-magnesian minerals, especially olivine.

Serpent kame; Serpentine kame. *See* Esker.

Serrate. Notched or toothed on the edge like a saw (Webster). Frequently applied to mountain ranges, as Saw-tooth mountains.

Serrucho. (Sp.). A handsaw with a small handle. (Halse)

Serve. To furnish; supply; as the gas wells *serve* the town with light and heat (Webster). Gas is said to "serve" when it issues more or less regularly from a fault-slip, a break, etc. (Gresley)

Service rails (Scot.). Rails used for a temporary purpose. (Barrowman)

Service road (Scot.). A temporary road. (Barrowman)

Serving (Corn.). A supply of tin ready for smelting. (Davies)

Set. 1. A timber frame for supporting the sides of a shaft or other excavation. Sometimes written Sett. 2. A group of pumps for lifting water from one level to another; a lift. 3. A group of mines under one lease. 4. A flat steel bar; a kind of crowbar. 5. A piece placed temporarily upon the head of a pile when the latter can not be reached directly by the weight or hammer. (Webster)
6. A train of mine cars; a trip. 7. To fix a prop or sprag in place. (Steel)
8. (So. Staff.) To mine the sides off and trim up a heading. 9. (No. of Eng.) To load a tub unfairly by placing the greater part of the coal on the top of it and leaving the bottom part comparatively empty. 10. (No. of Eng.) The natural giving way of the roof for want of support. 11. To make an agreement with miners to do certain work; *e. g.*, to set a stall. 12. (Mid.) A measure of length along the face of a stall, usually from, say, 6 to 10 feet, by which "holers" and "drivers" work and are paid. (Gresley)
13. The failure of a rock subjected to intense pressure below the point of rupture to recover its original form when the pressure is relieved. (Merrill)
14. The hardening of a plastic or liquid substance, as by chemical action (in case of mortar, cement, etc.) or by cooling, as in case of glue. (Webster)

Set coal (Leic.). Coal occurring near hollows and having a hard dead nature. (Gresley)

Set copper. Molten copper which, in the process of refining, has become saturated with cuprous oxide. (Eng. and Min. Jour. vol. 102, p. 875)

Set hammer. The flat-faced hammer held on hot iron by a blacksmith when shaping or smoothing a surface by aid of his striker's sledge. (C. and M. M. P.)

Set-off (Eng.). The part of a connecting-rod to which the bucket-rod is attached. (Bainbridge)

Set of timber. The timbers which compose any framing, whether used in a shaft, slope, level, or gangway. Thus, the four pieces forming a single course in the curbing of a shaft, or the three or four pieces forming the legs and collar, and sometimes the sill of an entry framing are together called a set, or timber set. (C. and M. M. P.)

Set-out (No. of Eng.). *See* Lay-out.

Set rider (Aust.). The man who accompanies a set of skips hauled by the main-and-tail-rope system, so that he can attend to any points on the track, unfasten the rope, and signal to the engine-driver as required (Power). The corresponding American term is trip rider.

Sett. 1. A quarryman's term for a square-faced steel tool which is held in position and struck with a sledge to cause a fracture in a rock mass. (Bowles)
2. *See* Set, 1.
3. (Corn.) A lease; the boundaries and terms of the mining ground taken by the adventurers. (Min. Jour.) *See* Set, 3.

Setter. A sagger made to hold one piece only of fine porcelain. (Standard)

Setters (No. of Eng.). Large lumps of coal placed round the sides of coal dealers' carts for the purpose of piling up a good load in the center. (Gresley)

Setting. 1. *See* Heading, 7. 2. *See* Square timbering. 3. (So. Staff.) *See* Double timber. 4. A group of retorts used in the manufacture of gas. (Webster)
5. (Eng.) The day and place of contracting with the men of a mine.
6. The act of contracting with miners for work to be done. (Standard)

Settle. 1. A term used to indicate the amount of vertical fire-shrinkage that takes place in a kiln full of bricks. (Ries)
2. To clear of dregs or impurities by causing them to sink, as of liquids.
3. To cause to sink; to depress; to render close or compact. (Webster)

Settle boards. 1. (No. of Eng.) Iron plates or sheets forming the floor of a heapstead, to admit of the tubs being pushed and turned about with facility (Gresley). Turn sheets.
2. (No. of Eng.) *See* Cage shuts. Also spelled Settle bords.

Settled production. The production of an oil well which, apart from the normal progressive annual dimunition, will last a number of years. (Redwood, p. 243)

Settler. A separator; a tub, pan, vat, or tank in which a separation can be effected by settling (Century). A tub or vat in which pulp from the amalgamating pan or battery-pulp is allowed to settle, being stirred in water, to remove the lighter portions. (Raymond)

Settlingite. *See* Settling stones resin.

Settling stones resin. A resinoid, hard, brittle substance, possessing a pale-yellow to deep-red color and a specific gravity of 1.16 to 1.54, and burning in a candle flame. It was found in an old lead mine in Northumberland, England. (Bacon)

Settling-vat. A vat in which particles of ore are allowed to settle. (Rickard)

Setts-off (Eng.). *See* Distance blocks.

Set-up. 1. In iron and steel manufacture, a machine for upsetting a bloom that has been lengthened by a squeezer. 2. An iron bolt or rod upset at one end. (Webster)
3. To place a drilling machine in position for drilling. 4. To orient a surveyor's transit over or under a point or station.

Seventy-two-hour coke. Owing to the suspension of labor on Sunday, an oven charged on Friday must necessarily go over to Monday, so that all charges made on Friday and drawn on Monday must be in the ovens 72 hours, and the coke resulting is called 72-hour coke. The 72-hour coke has higher ash, less volatile matter, less sulphur and is preferred for foundry purposes.

Sèvres. Sèvres porcelain. (Standard)

Sèvres blue (Fr.). 1. The lighter blue of the Sèvres porcelain, especially of pieces antedating the Revolution (1789) distinctively called *bleu céleste*. 2. The darker blue of Sèvres porcelain, distinctively called *bleu-du-roi*. (Webster)

Sèvres ware. A costly porcelain manufactured in Sèvres, France, especially in the National factory. (Webster)

Sewer brick. A general term applied to those common brick that are burned so hard as to have little or no absorption. They are, therefore, adapted for use as sewer linings. (Ries)

Shab (Som.). Friable, shaly rock. (Gresley)

Shack (Derb.). An irregular ore deposit. *See* Self-open. (Mander)

Shackle. A U-shaped link in a chain closed by a pin; when the latter is withdrawn the chain is severed at that point. (Steel)

Shadd (Corn.). Smooth, round stones on the surface, containing tin ore, and indicating a vein. (Raymond)

Shadoof. A counterpoised sweep used in Egypt and near-by countries for raising water, ore, etc. A hand whip.

Shadrach. *See* Salamander.

Shaft. 1. An excavation of limited area compared with its depth, made for finding or mining ore or coal, raising water, ore, rock, or coal, hoisting and lowering men and material, or ventilating underground workings. The term is often specifically applied to approximately vertical shafts, as distinguished from an incline or inclined shaft. 2. The interior of a shaft furnace above the boshes (Raymond). Compare Slop; Incline.
3. A wooden handle of a pick, etc.
4. (So. Wales) To pull or draw at a tub. (Gresley)

Shaft foot (Scot.). The bottom of a shaft. (Gresley)

Shaft furnace. A high furnace, charged at the top and tapped at the bottom. (Raymond)

Shaft house. A building at the mouth of a shaft, where ore or rock is received from the mine. (Weed)

Shaft kip (Eng.). *See* Kip.

Shaft lamp (Eng.). *See* Comet.

Shaft pillar. Solid material left unworked beneath buildings and around the shaft, to support them against subsidence (Steel). Also called High pillar.

Shaft rent (Eng.). 1. Rent paid for the use of a shaft for raising the minerals from another property. 2. Interest on capital invested in sinking a shaft. (Gresley)

Shaft set. A set of shaft timbers consisting of two wall plates, two end plates, and dividers which separate the shaft into two or more compartments.

Shaft station. An enlargement of a level near a shaft from which ore, coal, or rock may be hoisted and supplies unloaded.

Shaft tackle. A poppet-head (Standard). A headframe. *See* Poppet, 1.

Shaft tunnel (No. Staff.). Headings driven across the measures from shafts to intersect inclined seams. (Gresley)

Shaft walls. 1. The sides of a shaft. 2. (Newc.) Pillars of coal left near the bottom of a shaft. (Raymond)

Shaggy metal (Ches.). *See* Horse beans.

Shake. 1. A cavern, usually in limestone. (Raymond)
2. A close-joint structure in rock, due to natural causes, as pressure, weathering, etc. Used in the plural.

Shaking 1. The same as springing. *See* Shaking a hole. (Du Pont)
2. (Corn.) Washing ore (Min. Jour.). Ore dressing.

Shaking a hole. The enlargement of a blast hole, by exploding a stick of dynamite, so it will contain a larger amount of explosives for a big blast (Stanich *v.* Pearson Mining Co., 141 NW. Rept., p. 1100.) Also called a Shake blast. *See* Springing.

Shaking screen; Shaker. A flat screen, often inclined, which is given an oscillatory motion and is used for sizing coal. (C. and M. M. P.)

Shaking table. A slightly inclined table to which a lateral shaking motion is given by means of a small crank or an eccentric. One form is covered with copper plates coated with mercury for the purpose of amalgamatig gold or silver. Other forms are provided with ripples and used in separating alluvial gold. (Roy. Com.). Also used in ore dressing.

Shakudo (Jap.). A dark-blue alloy of copper with gold, used in Japanese metal work (standard)

Shale. A fine-grained, fissile, argillaceous, sedimentary rock characterized by rather fragile and uneven laminae and commonly a somewhat splintery fracture. Often, but incorrectly, called *slate* by miners, quarrymen, well-drillers, and others. (La Forge)

Shale naphtha. Naphtha obtained from shale oil. (Bacon)

Shale oil. A crude oil obtained from bituminous shales, especially in Scotland, by submitting them to destructive distillation in special retorts. (Bacon)

Shale-oil shale (Scot.). Shale yielding oil on distillation. This term was formerly used as signifying argillaceous rock. (Barrowman)

Shale spirit. The lower-boiling fractions obtained in the refining of crude shale-oil. (Bacon)

Shallow ground (Aust.). Land having gold near it's surface. (Standard)

Shaly. 1. Characteristic of, pertaining to, composed of, or resembling shale; having the characteristic structure and fissility of shale, as a *shaly* sandstone or limestone. (La Forge) 2. Brittle ground. (Ihlseng)

Shambles. Shelves or benches, from one to the other of which ore is thrown successively in raising it to the level above, or to the surface (Raymond). *See* Shammel.

Sham door (Eng.). A check or regulator door. (Gresley)

Shammel. 1. A stage for shoveling ore upon, or for raising water (Davies). *See* Shambles.
2. To work a mine by throwing the material excavated on to a stage or bench in the "cast after cast" method, which was the usual way before the art of regular mining by means of shafts had been introduced. (Century)

Shandy-gaff (Aust.). Shovel-filled coal (Power). Coal loaded by shovel without screening, hence containing an excess of fines. Run of mine coal.

Shangie (Scot.). A ring of straw or hemp put round a jumper in boring to prevent the water in the bore hole from splashing out. (Barrowman)

Shank. 1. (Scot.) A shallow shaft underground (Gresley). A winze.
2. The body portion of any tool, up from its cutting edge or bit. (C. and M. M. P.)
3. A ladle for molten metal, with long handles, for use by two or more men. (Webster)

Shanker (Scot.). A pit or shaft. (Barrowman)

Shanklin sand (Eng.). A marine deposit of siliceous sands and sandstone of various shades of green and yellow-gray. Also called Lower green-sand. (Humble)

Sharp gas (Eng.). Fire damp that explodes suddenly within a safety lamp without showing any preceptible cap. Gas is sharp when at its most explosive point. (Gresley)

Shastalite. Wadsworth's name for unaltered, glassy forms of andesite. (Kemp)

Shasta series. The Lower Cretaceous of the Pacific coast, entirely marine, the Knoxville beds below, and the Horsetown above (Standard). Usage now obsolete.

Shatter. To break at once into pieces; to dash, burst, or part violently into fragments; to rend into splinters. (Webster)

Shattered zone. Applied to a belt of country in which the rock is cracked in all directions, resulting in a network of small veins. (Power)

Shaula (Braz.). A shovel. (Halse)

Shaven latten. Very thin sheet brass. (Standard)

Sheaf. A bundle or pile containing 30 ingots of steel. (Standard)

Shear. 1. To make into shear-steel by condensing blister steel and making it homogeneous. 2. To make vertical cuts in a coal seam that has been undercut. *See* Shearing, 1. (Standard)

Shearing. 1. The vertical side-cutting which, together with holing or horizontal undercutting, constitutes the attack upon a face of coal. 2. Cutting up steel for the crucible (Raymond). 3. The act of cutting a vertical groove in a coal face or breast. Called in Arkansas a *cut* or *cutting*. (Steel)
4. The deformation of rocks by cumulative small lateral movements along innumerable parallel planes, generally resulting from pressure, and producing schistosity, cleavage, minute plication, and other metamorphic structures. (La Forge)

Shear legs. 1. A high wooden frame placed over an engine or pumping shaft fitted with small pulleys and rope for lifting heavy weights (C. and M. M. P.). *See also* Shears, 1.
2. A tripod on which miners sometimes stand in drilling. (Standard)

Shears. 1. (Corn.) Two high timbers, standing over a shaft and united at the top to carry a pulley for lifting or lowering timbers, pipes, etc., of greater length than the ordinary hoisting gear can accommodate. (Raymond)
2. (Scot.) A haulage clip. (Gresley). Called also Sheers.

Shear steel. A steel produced by heating blister steel (sheared to short lengths) to a high heat, welding by hammering or rolling, or both, and finally finishing under the hammer at the same or slightly greater heat. (Webster)

Shear structure. In geology, a structure resulting from the shearing of rocks, as in crushing, crumpling, etc. (Webster)

Shear zone. In geology, a zone in which shearing has occurred on a large scale, so that the rock is crushed and brecciated. (La Forge)

Sheathing deals (Scot.). Deals (plank) nailed to cribs all round a shaft to preserve the cribs from injury and make the sides of the shaft smooth. (Barrowman)

Sheaths (Newc.). The upright framing of a coal wagon or car. (Min. Jour.)

Sheave. A wheel with a grooved circumference over which a rope is turned, either for the transmission of power or for hoisting or hauling (Chance). Any grooved wheel or pulley. (Webster)

Shed. 1. (Penn.) A kind of long car or trolley. 2. (Eng.) A thin, smooth parting in rocks, having both sides polished. 3. (Eng.) A very thin layer of coal. (Gresley)

Shed-line. The summit line of elevated ground; the line of a watershed. (Century)

Sheepbacks. *See* Roches montonnées.

Sheep silver (Scot.). Mica. (Standard)

Sheer legs. *See* Shear legs.

Sheers. *See* Shears, 2.

Sheet. 1. In iron and steel manufacture, a portion of metal less than about ¼ inch thick. That which is heavier is designated as *plate*.
2. In geology, an extensive bed of an eruptive rock intruded between, or overlying, other strata. (Webster)
3. (Aust.) A solid body of pure ore filling a crevice. (Power)
4. (Upper Mississippi lead region) Galena in thin and continuous masses. The ore itself is called *sheet* mineral. (Century)

Sheet-asphalt pavement. A pavement having a wearing course composed of asphalt, cement and sand of predetermined grading, with or without the addition of fine material. (Bacon)

Sheet deposit. A mineral deposit extended in length and breadth and having relatively small thickness, thus including both lodes and beds as distinguished from irregular masses. The term has been sometimes applied in a more limited sense to deposits (called also blanket veins) occurring in an approximately horizontal plane. (Webster)

Sheet ground (Mo.). A term in the Joplin district applied to horizontal, low-grade, disseminated zinc-lead deposits, covering an extensive area. *See* Sheet deposit.

Sheet ice. Ice formed on a body of water by the cold air above it. (Standard)

Sheeting. The development, in rock formations, of small closely spaced parallel fractures. (Farrell)

Sheet iron. *See* Sheet, 1.

Sheet-iron pitch. The inclination of a coal seam at which loose coal will not move on the natural bottom, but at which it will slide or can be easily pushed along on iron slides placed on the bottom in the chambers or rooms.

Sheet metal. *See* Sheet, 1.

Sheet mineral. *See* Sheet, 4.

Sheet pile. Any of a number of thick boards or planks wedge-shaped at the lower end and sometimes tongued on one edge and grooved on the other, driven into the ground close together between gauged piles to form the walls of a cofferdam. A sheet-steel device is also used for the same purpose. (Webster)

Sheet quarry. A term often used in granite quarrying, to designate a quarry having strong horizontal joints and a few vertical ones. (Ries)

Sheets (Eng.). Coarse, cloth curtains or screens for directing the ventilation underground. *See* Brattice cloth. (Gresley)

Shelf (Corn.). 1. The solid rock or bed-rock, especially under alluvial tin-deposits. (Raymond)
2. A charging-bed in a furnace at a higher level than the working-bed. (Standard)
3. A rock, ledge of rocks, reef or sandbank in the sea. 4. A projecting layer or ledge of rock on land. (Century)

Shell. 1. A torpedo used in oil wells.
2. A metal or paper case which holds a charge of powder.
3. A thin, hard band or layer of rock encountered in well boring. (Redwood)

Shell band. *See* Mussel band.

Shell door (Eng.). A temporary door. (Gresley)

Shell limestone. A sedimentary rock composed chiefly of fragments of fossil shells. (La Forge)

Shell marble. An ornamental marble containing fossil shells. (Century)

Shell marl. A light-colored calcareous deposit in the bottoms of small lakes, composed largely of fresh-water shells, but apparently also to some extent of precipitated carbonate of calcium and the hard parts of minute organisms. (Roy. Com.)

Shell pump. A simple form of sand pump or sludger consisting of a hollow cylinder with a ball or clack valve at the botton, used with a flush of water to remove detritus. (Webster)

Shell sand. Sand chiefly or largely composed of fragments of shells. (Standard)

Shelly. A name applied to coal that has been so crushed and fractured that it easily breaks up into small pieces (Chance). Broken ground.

Shepherd (Aust.). A miner who preserves legal rights to a mining claim with the least amount of work on it. (Standard)

Shepherding (Aust.). Keeping possession of a mining claim by doing the least amount of work on it allowed by law. (Davies)

Sherardize. To galvanize by inclosing the articles to be treated, covered with a commercial zinc dust, in a tightly closed retort, heating and allowing to cool. (Webster)

Sherd. A fragment of pottery. In petrography applied particularly to the characteristic crescentic or cuspate particles into which volcanic glass is sometimes blown, while still hot, by the expansive force of included gases. The glass particles of tuff often show such cuspate outlines. (Ransome)

Sherman settler. A series of cylindrical tanks with conical bottoms having central feed and a peripheral overflow. The tanks continually decrease in depth and increase in diameter. (Liddell)

She's fired (Eng.). An expression used when an explosion of fire damp has taken place in the pit. *See* Squat lads. (Gresley)

Shet (So. Staff.). The broken-down roof of a coal mine. (Raymond)

Sheth. 1. (Eng.) An old term denoting a district of about eight or nine adjacent bords. Thus a "sheth of bords," or a "sheth of pillars." (C. and M. M. P.)
2. (No. of Eng.) To course the air in the workings. *See* Coursing. 3. (No. of Eng.) The rib of a chaldron wagon. *See* Sheaths (Gresley)

Sheth door (No. of Eng.). A temporary door placed in a working heading. (Gresley)

Shething the air (No. of Eng.). Ventilating the goaves in a systematic way. (Gresley)

Sheth of bords (Eng.). *See* Sheth, 1.

Sheugh. 1. (Scot.). To make ditches or drains in; to dig, as peat, by making ditches (Webster). Also Sheuch.
2. (Scot.) A shaft or coal pit. (Gresley)

Shicer (Aust.). An unproductive mine (Webster). A mining claim without gold. (Standard)

Shides (Brist., Scot.). Pumps for draining mines. (Gresley)

Shield. In mining or tunneling, a framework or screen of wood or iron protecting the workers, pushed forward as the work advances. (Standard)

Shift. 1. The length of time a miner works in one day. 2. The gang of men working for the period; as the day shift, the night shift. (Hanks)
3. A fault of dislocation. (Gresley)
4. The maximum relative displacement of points on opposite sides of the fault and far enough from it to be outside the dislocated zone. Also called Net shift. *See* Strike shift, Dip shift, Normal shift, and Vertical shift. (Lindgren, p. 122)

Shift boss. The foreman in charge of a shift of men. (Raymond)

Shifter. 1. *See* Bottomer. 2. (No. of Eng.) One who repairs roadways in a mine. (Gresley)
3. (Newc.) A man who prepares the working places in a coal mine at night. (Min. Jour.)

Shift-joint. In masonry, a break-joint. (Standard)

Shiftmen (Aust.). Men engaged on a time-wage basis working at various jobs (Power). Also called Company men.

Shiftwork (Eng.). Work performed underground for which wages are paid on a time basis; *e. g.*, timbering, road cleaning, etc. (Gresley)

Shindle. A roofing slate. (Standard)

Shingle. 1. Loosely and commonly, any beach gravel which is coarser than ordinary gravel, especially if consisting of flat or flattish pebbles. 2. Strictly and properly, beach gravel composed of smooth, well rounded pebbles of roughly the same size, the interstices between which are not filled with finer material as in ordinary gravel, and which gives out a musical note when trod upon. (La Forge)
3. In iron manufacture, to drive out scoriae and other impurities from (puddled iron) by heavy blows or pressure. (Standard)

Shingler. A machine for squeezing puddled iron; also, the workman who attends such a machine. (Standard)

Shingle tile. A flat form of roofing tile. (Ries)

Shingley coal (Newc.). Small coal free from dust. (Min. Jour.)

Shingling. Hammering blooms, billets, etc. (Raymond). Called also Blooming.

Shingling hammer. A tilt-hammer for making blooms. (Standard)

Shingling tongs. Large tongs for handling blooms in shingling. (Standard)

Shingly. Composed of, or abounding in, shingle or coarse detritus (Webster. *See* Shingle, 1.

Shining. As applied to the degree of luster of minerals, means those which produce an image by reflection, but not one well defined, as celestite. (Dana)

Shipper. 1. (Aust.). An instrument used for placing an endless rope on its rollers in cases where it gets off them. (Power)
2. (U. S.) *See* Snowbird mine.

Shipping ore. Any ore of greater value when broken than the cost of freight and treatment. (Morrison)

Ship plate. Low-grade iron plate. (Standard)

Ship-po. In ceramics, Japanese cloisonné-enamel ware. (Standard)

Shirt. The inner lining of a blast furnace. (Standard)

Shist. *See* Schist.

Shiver. 1. Shale; a hard argillaceous bed. *See* Sheave. (Raymond)
2. A variety of blue slate. (Standard)

Shiver spar. A variety of calcite, of slaty structure; slate spar. (Webster)

Shivery post (Eng.). *See* Scamy.

Shoad. *See* Shode.

Shock-proof. As applied to the current-carrying parts of an electric system (excepting trolley wires) is taken to mean that contact with such parts is prevented by the use of grounded metallic coverings or sheaths. (H. H. Clark)

Shode. 1. (Corn.) A loose fragment of vein stone. Ore washed or detached from the vein naturally. *See* Float ore.
2. (Eng.) To search for ore by tracing the shode (Webster). Spelled also Shoad.

Shode-pit. An excavation made in tracing shodes. (Standard)

Shoder. The package of gold-beaters' skin in which the thin metal sheets are hammered in the second stage of making gold-leaf. (Standard)

Shode stone. *See* Shode, 1.

Shoding; Shoading (Corn.). The tracking of bowlders toward the vein or rock from which they have come. (Raymond)

Shoe. 1. A piece of iron or steel, attached to the bottom of a stamp or muller, for grinding ore. The shoe can be replaced when worn out. (Raymond)
2. The bottom wedge-shaped piece attached to tubbing when sinking through quicksand. 3. Steel pieces fastened to the ends or sides of cages, which slide on guides when the cage is in motion. (Power)
4. In glass-making, a small opening into which the blower passes his rod to heat it. (Webster)
5. A trough to convey ore to a crusher. 6. A boat-shaped ingot of sycee silver weighing about 66½ ounces. (Standard)

Shoe-nose shell. A cylindrical tool, cut obliquely at bottom, for boring through hard clay. (Raymond)

Shoe shell (Eng.). A tool used in deep boring for cleaning out the drill cuttings. It has a valve at the bottom, opening upward (Gresley). A sand pump or bucket.

Shoes of silver (E. Asia). Ingots of precious metal popularly thought to resemble a shoe. (Standard)

Shoe-string claim. A mining claim in the form of a long narrow strip. (Hanson *v.* Craig. 170 Fed. Rept., p. 65; Snowflake Fraction Placer, 37 Land Decisions, p. 250). (U. S. Min. Stat., p. 538)

Shonkinite. A name given by Weed and Pirsson to a rock from the Highwood Mountains, Mont., which they define as "a granular, plutonic rock consisting of essential augite and orthoclase, and thereby related to the syenite family. It may be with or without olivine, and accessory nepheline, sodalite, etc., may be present in small quantities." (Kemp)

Shoo-fly. Any crosscut between a haulageway and airway through which cars are run. *See also* Slant, 1.

Shoot. 1. *See* Chute, 1. 2. *See* Blast. A shot is a single operation of blasting. 3. An elongated body of ore. *See* Chute, 2. (Raymond) 4. To torpedo an oil or gas well.

Shooter. 1. (Aust.) The man who fires a charged hole after satisfying himself that the place is free from fire damp (Power). A shot firer.
2. In the petroleum industry, one who shoots oil wells with nitroglycerin to loosen or shatter the oil-bearing formation.

Shooting (Eng.). Blasting in a mine. (Gresley)

Shooting a well. Exploding a charge of nitroglycerin in a drill hole, at or near an oil-bearing stratum, for the purpose of increasing the flow of oil.

Shooting fast (Lanc.). Blasting without previously holing or shearing the coal (Gresley). *See* Shooting off-the-solid.

Shooting-needle. A blasting needle; a metallic rod used in the stemming of a drill hole for the purpose of leaving a cavity through which the charge may be fired. (Century)

Shooting off-the-solid. Mining the coal by heavy blasting without undermining or shearing it (Steel). In England called Shooting fast.

Shooting on-the-free. The use of a small charge of powder to blow down the face of the coal after it has been undercut as distinguished from "shooting off-the-solid." (Andricus *v.* Pineville Coal Co., 121 Kentucky, p. 728)

Shooting the gob (No. Staff.). Working the coal in the pillars of inclined coal beds by blasting. (Gresley)

Shoot of ore. A body of ore with relatively small horizontal dimensions and steep inclination in a lode; in contradistinction to a *course of ore*, which is flatter (Power). *See* Chute, 5.

Shop. In glass-making, a team of workmen. (Standard)

Shore (Eng.). A studdle or thrusting stay. (C. and M. M. P.)

Shore terrace. A terrace made along a coast by the action of waves and shore currents; it may become land by the uplifting of the shore or the lowering of the water. (Webster)

Shore up. To stay, prop up, or support by braces. (Steel)

Shorn (Eng.). Cut with a pick, as in undercutting coal. (Gresley)

Short. Brittle; friable; breaking or crumbling readily; inclined to flake off (Century). Said of coal.

Short and rough. Unmellowed, as by weathering, said of brick clay, as distinguished from *mild and tough*. (Standard)

Short-fire. *See* Underfire, 1.

Short-fired. Not enough baked; underfired; said of porcelain, etc. (Standard)

Short-flame explosive. *See* Permissible explosive.

Short fuse. 1. Any fuse that is cut too short. 2. The practice of firing a blast, the fuse on the primer of which is not sufficiently long to reach from the top of the charge to the collar of the bore-hole. The primer, with fuse attached, is dropped into the charge while burning, and tamping may, or may not, be attempted. It is an exceedingly dangerous practice. (Du Pont)

Short hole. A blast-furnace tap-hole with a short stopping which may break out unexpectedly when drilled into. (Willcox)

Short leg. One of the wires on an electric blasting cap, which has been shortened so that when placed in the bore-hole, the two splices or connections will not come opposite each other and make a short circuit. (Du Pont)

Shorts. 1. The product remaining on the screen when the material collected from the zinc boxes of a cyanide mill is rubbed over a sieve. *See* Fines. (Clennell)
2. (Eng.) The contents of cars filled with coal, or coal and dirt mixed, otherwise than in accordance with the colliery regulations. 3. (Eng.) Deficiency of mineral worked under a lease during any year or other period agreed upon. (Gresley)

Short stall (Mid.). A single-road stall. (Gresley)

Short ton. A ton of 2,000 pounds avoirdupois, a long ton being 2,240 pounds avordupois. Also called Net ton.

Shortwall machine. A coal cutter for use in bords, which when once the cutting part has made the sumping cut, is drawn across the face automatically by ropes, undercutting as it proceeds. (Power)

Short workings (Eng.). *See* Shorts, 3.

Shoshonite. 1. An aphanorphyric igneous rock composed essentially of dominant andesine and oligoclase and subordinate orthoclase, augite, and olivine. (La Forge) 2. A general name proposed by Iddings for a group of igneous rocks in the eastern portion of the Yellowstone Park. They are porphyritic in texture, with phenocrysts of labradorite, augite, and olivine, in a groundmass that is glassy or crystalline; in the latter case orthoclase and leucite, alone or together, are developed. The rocks are to be considered in connection with absarokite and banakite. (Kemp)

Shot. 1. A charge or blast. *Balanced shot*, a shot so placed that the hole containing the powder is parallel to one face of the coal to be broken. *Blown-out shot*, a shot which merely throws out the stemming without loosening much coal. *Cutting shot*, a shot arranged to loosen the coal prepared by the cutting and to scatter the coal in advance to facilitate the making of another cutting. *Gouging shot* (Ark.), a gripping shot or opening shot in a straight face, as to start a break-through. *Gripping shot*, a shot which is farther from the face of the coal at the point than at the heel; also called *wedging shot*. *Opening shot*, the first gripping shot fired, in a straight face of coal. *Slitting shot*, a shot put into a large mass of coal detached by a previous blast. *Windy shot*, a shot which causes a concussion in the air, usually by an excessive amount of powder behind an easily loosened mass of coal 2. The firing of a blast: 3. Injured by a blast. (Steel)
4. A small globular mass, or pellet, of metal, *e. g.*, steel, and as such used in drilling operations. *See* Adamantine drill.

Shot copper. Small rounded particles of native copper, somewhat resembling small shot in size and shape. (Weed)

Shot drill. An earth-boring drill using steel shot as an abrasive. *See* Adamantine drill.

Shot-fast. Coal mined by blasting. (Gresley) Shot-off-the-solid.

Shot firer. A man whose special duty is to fire shots or blasts, especially in coal mines. Also Shot lighter (Hargis). Called Shooter in Australia.

Shot hole. The borehole in which an explosive is placed for blasting. (Gresley)

Shot lighter. *See* Shot firer.

Shot metal. An alloy of 98 per cent lead and 2 per cent arsenic, for making small shot. (Webster)

Shot samples. Samples taken for assay from molten metal by pouring a portion into water to granulate it. (Webster)

Shotty gold. Small granular pieces of gold resembling shot. (C. and M. M. P.)

Shoulder cutting (So. Staff.). Cutting the sides of the upper lift of a working place in a thick-coal colliery next the rib, preparatory to breaking the coal. (Gresley)

Shovel-filled (Aust.). Run-of-mine coal as broken at the face. (Power)

Show. 1. The pale-blue, lambent flame on the top of a common candle flame, indicating the presence of fire damp (Raymond). A "show of gas" is a phrase denoting a quantity just sufficient to form a perceptible cap above the flame of a lamp or candle.
2. The first appearance of float, indicating the approach to an outcropping vein or seam. *See* Blossom. (C. and M. M. P.)

Shrinkage-crack. One of a series of cracks, or of filled-up cracks, often seen on rock surfaces; supposed to have resulted from the drying and

shrinking of the layer while it was plastic mud. Called also Sun-crack. (Standard)

Shrinkage stoping. Also known as "back stoping," "shrinkage with waste fill," "overhand stoping with shrinkage and delayed filling," and "overhand stoping with shrinkage and no filling." The method is a modification of overhand stoping and its characteristic is the use of a part of the ore for the purpose of support and as a working platform. As applied to small ore bodies two modifications are used: stoping without ore passes (chutes) and stoping with ore passes (surplus ore is removed by means of the ore passes). As applied to large ore bodies the stopes are separated by pillars or ribs and the name used is "shrinkage stoping with alternate pillar and stope." (Young)

Shrinkage with waste fill. *See* Shrinkage stoping.

Shropshire method. *See* Longwall method.

Shroud. A housing or jacket (Chance). Especially a housing around gear wheels.

Shut; Shutt (So. Staff.). 1. The crushed and broken-down roof of a seam of coal. 2. Old workings. *See* Goaf, 1. (Gresley)

Shutdown. A term denoting that work has been temporarily stopped, as on an oil well. *See* Standing. (Redwood)

Shute. *See* Chute.

Shut-in. In geology, a narrow gorge cut by a superposed stream across a ridge of hard rock between broad valleys of softer rock on each side of the ridge. (Standard)

Shuts (Scot.). Movable or hinged supports for the cage at a shaft landing (Barrowman). Also called Keps, Keeps, Chairs, Dogs, Seats.

Shutter. 1. A movable sliding door, fitted within the outer casing of a Guibal or other closed fan, for regulating the size of the opening from the fan, to suit the ventilation and economical working of the machine. 2. A slide covering the opening in a door or brattice, and forming a regulator for the proportionate division of the air current between two or more districts of a mine. (Steel)

Shuttles (Lanc.). Natural cracks running at right angles to the dip of the strata. (Gresley)

Shut up. 1. To weld together, as pieces of metal. 2. To condense, as porous metal, by hammering or pressure. (Standard)

Siam ruby. A name sometimes erroneously applied to the dark ruby spinel found with the rubies of Siam. (Century)

Siberian aquamarine. A blue-green beryl found in Siberia. (Century)

Siberian ruby. Rubellite; a red variety of tourmaline found in Siberia. (Power)

Siberite. A violet-red variety of Rubellite (Dana) *See* Siberian ruby.

Sickening. The flouring of mercury. *See* Floured.

Sicker. *See* Zighyr.

Sicilian oil. Petroleum. It was used, under this name, for illuminating purposes at Agrigentum, Sicily, before the beginning of the Christian era (Bacon)

Siddle. The inclination of a seam of coal. (Raymond)

Side. 1. The more or less vertical face or wall of coal or goaf forming one side of an underground working place. 2. (Lanc.) A district. (Gresley)
3. The wall of a vein. (Power)

Side adits. A side passage sometimes made when the main adit is choked with waste rock. (Davies)

Side-basse. A transverse direction to the line of dip in strata. (Raymond)

Side chain. A chain hooked on to the sides of cars running on an incline or along a gangway, to keep the cars together in case the coupling breaks. (Steel)

Side-dumper. An ore, rock or coal car that can be tilted sidewise and thus emptied.

Side guide. *See* Guard, 1.

Side-laning (So. Staff.). The widening of an abandoned gate road, and making it part of the new side of work. (Min. Jour.)

Side lengths. *See* Lengths.

Side line. 1. A line attached to the side of a dredge and used to hold the dredge in place during operations. (Weatherbe)

2. A surface line on each side of the middle of the vein which measures the length of the claim along the vein. It bounds the side of the claim. (Argentine Mining Co. *v.* Terrible Mining Co., 122 United States, p. 485)

Sidelong reef. An overhanging wall of rock in alluvial formations extending parallel with the course of the gutter; generally only on one side of it. (C. and M. M. P.)

Side of work (So. Staff.). The series of breasts and pillars connected with a gate road in a colliery. (Raymond)

Side-over (No. of Eng.). To cut or drive in a line with the cleat through a pillar of coal when robbing pillars. (Gresley)

Side plate. In timbering, where both a cap and a sill are used, and the posts act as spreaders, the cap and the sill are spoken of as the side plates. *See* End plate, *also* Wall plate. (Sanders, p. 10)

Sidergia (Sp.). Metallurgy of iron. (Halse)

Siderite. 1. Spathic iron ore. Iron carbonate, $FeCO_3$. Contains 48.2 per cent iron (U. S. Geol. Surv.) Also called Chalybite; Sparry iron ore; Spathic iron.
2. An indigo-blue variety of quartz.
3. An iron meteorite. (Standard)

Siderocconite. A variety of calcite colored yellow or yellowish-brown by hydrated iron-oxide. (Century)

Siderodot. A calciferous variety of siderite. (Chester)

Sideroferrite. A name given to native iron found in petrified wood. (Chester)

Siderography. Art of engraving on steel. (Webster)

Siderolite. As used by Fletcher and generally in English, is a name for meteorites that are partly metallic iron and partly silicates. As used by others, it is applied to more purely metallic ones. (Kemp)

Sideromagnetic. Same as Paramagnetic.

Sideromelane. A basaltic glass from the palagonite tuffs of Sicily. (Kemp)

Siderophyllite. A black variety of biotite in which the magnesium is partly replaced by ferrous iron. (Standard)

Siderosa (Sp.). Spathic iron ore; siderite. (Halse)

Sideroscope. An instrument for detecting small quantities of iron by the magnetic needle. (Webster)

Siderosis. A lung disease due to inhaling particles of metallic iron. (Century)

Siderotechny. The art of working iron. (Standard) Usage now obsolete.

Siderurgy. The metallurgy of iron and steel. (Webster) Usage now obsolete.

Sides (N. Y. and Pa.). A local term applied by bluestone quarrymen to open joints that extend east and west. (Bowles)

Side shear. *See* Grip, 3.

Side spit. The emission of sparks through the sides of a burning fuse. (Du Pont)

Side stoping. *See* Overhand stoping.

Side-wafer; Side-waver (No. of Eng.). 1. Overhanging stones or roof in underground roads liable to drop. 2. A fall of fire clay. (Gresley)

Siding over. A short road driven in a pillar in a headwise direction. (C. and M. M. P.)

Siding tile. Any roofing tile employed for upright work. (Ries)

Siegburgite. A fossil resin from the brown coal near Bonn, Germany; it varies in color from golden yellow to brownish red, and is partly soluble in alcohol and ether. (Bacon)

Siege. The floor of a glass furnace. (Standard)

Siemens and Halske process. A metallurgical process for the recovery of copper. Copper sulphides are dissolved by solutions of ferric sulphate containing free sulphuric acid. The solution is then electrolyzed in a tank having a diaphragm. Copper is deposited and ferric sulphate regenerated. (Liddell)

Siemens direct process. A process for making wrought iron directly from iron ore, without the previous production of pig iron. (Standard)

Siemens furnace. A reverberatory furnace, heated by gas, with the aid of regenerators. (Raymond)

Siemens-Martin process. The production of steel in a reverberatory furnace by oxidation of the impurities by oxides added (either the rust on scrap, or mill scale, or pure ores). It may be conducted either on an acid or a basic lining (Liddell). *See also* Open-hearth process.

Siemens-Martin steel. Steel in which pig iron is decarburized by the Siemens-Martin process (which *see*). (Standard)

Siemens producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 311)

Siemens-Silesian furnace. A Silesian zinc-distillation furnace employing the Siemen's system of heat recuperation. (Ingalls, p. 409)

Sienita (Sp.). Syenite. (Dwight)

Sienna. A brownish orange-yellow clay colored by iron and manganese oxides. Used as a pigment. (U. S. Geol. Surv.)

Sienna marble. One of the most highly esteemed of marbles for interior decoration. The prevailing color is yellow, but often variegated with white and violet or purple. From Monte Arenti, in Montagnola, Tuscany. (Merrill)

Sierra (Sp.). A saw. A chain of hills or mountains; used as part of the name of many mountain chains, as *Sierra* Nevada. (Century)

Sieve. The screen or grating fixed in a stamp-box. Any screen.

Sieve mesh. The length of the side of a hole in a sieve (Hunt). *See* Mesh, 1.

Sieve raggings (Eng.). Pieces of ore deposited at the bottom of a sieve. (Hunt)

Sifón (Sp.). 1. Downtake of blast furnace. 2. A siphon. (Dwight)

Sigger. *See* Zighyr.

Sight. 1. A bearing or angle taken with a compass or transit when making a survey. 2. Any established point of a survey (Steel). A bob or weighted string hung from an established point in the roof of a room or entry, to give direction to the men driving the entry or room. (C. and M. M. P.)

Sigillated ware. Pottery decorated with stamped patterns; stamped ware. (Standard)

Sigillation. Decoration of pottery with stamped patterns. (Standard)

Sigmoidal fold. A reversed or inverted fold; a mass of strata which as the result of crust movements have been turned back on themselves into a form resembling the Greek letter sigma (Century). Usage obsolete.

Signal bell, or Hammer (Scot.). A bell or other appliance for signaling in mine shafts or on haulage roads. (Barrowman)

Signal wire (Scot.). Thin wire strand used for operating signal hammers and bells. (Barrowman)

Sil (L.). Yellow ocher. (Standard)

Silesian furnace. A rectangular, combustion chamber containing about 20 muffles for the distillation of zinc. The furnaces are commonly built in pairs with chambers between each for the calcination of the ore. (Ingalls, p. 396)

Silesian method. A metallurgical process characterized by a large charge of lead ore, slow roasting, and a low temperature. It is not aimed to extract all the lead in the reverberatory, as this is supplemented by the blast furnace. The hearth is inclined toward the flue, beneath which the lead is collected and tapped at intervals into an outside kettle. (Hofman, p. 105)

Silex. *See* Silica, 1.

Silica. 1. An oxide of silicon, SiO_2. Occurs in nature as a mineral of economic importance in quartz, chalcedony, chert, flint, opal, diatomaceous earth and sandstone. The most abundant constituent of the earth's crust. *See also* Agate, Quartz, Glass sand (U. S. Geol. Surv.). Also known as Silex, and used for lining tube mills.
2. (Local, U. S.) Very fine white disintegrated chert, used in pottery manufacture.

Silicalite. Wadsworth's name for rocks composed of silica, such as diatomaceous earth, tripoli, quartz, lydite, jasper, etc. (Kemp)

Silicate. 1. A salt or ester of any of the silicic acids. In mineralogical chemistry the silicates are of great importance, forming by far the largest group of minerals. (Webster)
2. A term used in the Joplin (Mo.), district for zinc carbonate.

Silicate cotton. Slag wool; mineral wool.

Silicated marble. A marble that contains silicates such as pyroxenes, amphiboles, mica, or chlorite. (Bowles)

Silicatization. The process of changing to a silicate. (Standard)

Siliceous. Of or pertaining to silica; containing silica, or partaking of its nature (Webster). Containing abundant quartz. Also spelled Silicious.

Siliceous sinter. *See* Fiorite.

Silicic. 1. In petrology, containing silica in dominant amount. 2. In chemistry, containing silicon as the acid-forming element. (La Forge)

Silicic acid. 1. Same as silica. 2. An amorphous gelatinous compound (H_4SiO_4), consisting of silica and water, into which constituents it readily decomposes. Called also Orthosilicic acid. (Standard)

Silicification. The entire or partial replacement of rocks and fossils with silica, either as quartz, chalcedony, or opal. (Kemp)

Silicified. Made into silica. Organic remains, both plant and animal, are often thus converted. (Winchell)

Silicified wood. *See* Wood, 2.

Silicious. *See* Siliceous.

Silicon. A nonmetallic element occurring abundantly in nature, being, next to oxygen, the chief elementary constituent of the earth's crust. As separated, it forms a grayish-white metallic-looking mass. Symbol, Si; atomic weight, 28.3; specific gravity, 2.34. (Webster)

Silicon bronze. A very strong, practically noncorrosive alloy of copper, tin, and silicon. (Webster)

Silicon copper. An alloy of copper (80–70 per cent) and silicon (20–30 per cent) used as an ingredient to free molten copper or brass from oxygen. (Webster)

Silicon iron. Iron containing 2 to 15 per cent of silicon, for improving cast iron; ferrosilicon. (Standard)

Siliconize. To unite or cause to unite with silicon, as in the combination of iron with silicon in certain metallurgical processes. (Standard)

Silicon spiegel. A spiegeleisen containing 15–20 per cent of manganese and 8–15 per cent of silicon used in making certain special steels. (Webster)

Silicon steel. A variety of steel containing considerable silicon, usually 2 to 3 per cent. It is very hard, but brittle, and difficult to work. (Webster)

Silicon ware. A slightly glazed stoneware made at Lambeth, England. (Standard)

Silicosis. An affection of the lungs occurring in stonecutters, caused by the inhalation of quartz dust (Webster). The term applies to miners also.

Silk. A silky luster in some precious stones, as the ruby; due to microscopic crystals. (Standard)

Silky. Having the luster of silk, like fibrous calcite, fibrous gypsum. (Dana)

Sill. 1. An intrusive sheet of igneous rock, of approximately uniform thickness, which is slight compared with the lateral extent, forced between level or gently inclined beds. (La Forge)
2. A piece of wood laid across a drift to constitute a frame with the posts and to carry the track of the tramway. (Raymond)
3. (Cumb., York.) Much the same as Clunch, Spavin, Warrant. (Gresley)
4. The floor of a gallery or passage in a mine. (Standard)

Silla (Sp.). 1. A chair. 2. A saddle. 3. A leather strap to protect the shoulders when carrying ore. (Halse)

Sillimanite; Fibrolite. A basic orthosilicate of boron and calcium, $H_2O.2CaO.B_2O_3.2SiO_2$. (Dana)

Sillite. Gümbel's name for a rock from Sillberg, in the Bavarian Alps, variously referred by others to gabbro, diabase, mica-syenite, and mica-diorite. (Kemp)

Silt. 1. A general name for the muddy deposit of fine sediment in bays or harbors, and one much employed in connection with engineering enterprises. (Kemp)
2. A name applied to the fine materials such as culm, ashes, etc., that are flushed into a mine in hydraulic mine-filling.

Silting. *See* Hydraulic mine-filling.

Silundum. A trade name for a form of silicon carbide; produced in an electric furnace, and possessing great hardness, high electrical resistance, and not subject to oxidation below 2,912° F. (Webster)

Silurian. The third in order of age of the geologic periods comprised in the Paleozoic era, in the nomenclature in general use. Also the system of strata deposited during that period. (The above usage, in which the term is restricted to the period following the Ordovician and preceding the Devonian, is the one now prevalent. Formerly Silurian included what is now called Ordovician, and it has been used by some geologists to include the Cambrian also.) (La Forge)

Silver. A white metallic element, sonorous, ductile, very malleable, and capable of a high degree of polish. Symbol, Ag; atomic weight, 107.88; specific gravity, 10.5. (Webster)

Silver glance. The native silver sulphide, Argentite.

Silvering. 1. A plating or covering of silver or an imitation of it, as applied to any surface; as, the *silvering* on the back of a mirror. 2. The art or process of coating surfaces with, or as with, silver. (Standard)

Silver-king (Colloq. U. S.). A wealthy silver-mine owner. (Standard)

Silver lead. Lead containing silver. (Standard)

Silver mill. The mill or metallurgical plant used in treating silver ores by either the wet or dry process. (Century)

Silver ores. Sometimes found native. *See* Acanthite, Amalgam, Argentite, Brongniardite, Bromyrite, Calaverite, Cerargyrite, Dyscrasite, Electrum, Embolite, Freibergite, Freieslebenite, Hessite, Iodyrite, Krennerite, Nagyagite, Petzite, Polybasite, Proustite, Stephanite, Stetefeldite, Stromeyerite, Sylvanite, Xanthoconite. (U. S. Geol. Surv.)

Silver plate. Ware plated with silver. (Standard)

Silver powder. A powder used in japanning, composed largely of bismuth, tin, and mercury; also, finely precipitated silver for electroplating. (Standard)

Silver sand. A sharp fine sand of a silvery appearance used for grinding lithographic stones, etc. (Century)

Silver-solder. A silver alloy of comparatively low fusibility, used by silversmiths. (Standard)

Silver State. Nevada. So called by reason of the large production of silver from the Comstock lode.

Silver-steel. An alloy of steel with a very small quantity of silver. (Standard)

Silvery iron. A light-gray, fine-grained quality of cast iron. (Standard)

Simetite. A resin near succinite from near Mt. Etna, Sicily; it is remarkable for its deep red color, contains but 0.4 per cent of succinic acid, and has a specific gravity of from 1.052 to 1.068. (Bacon)

Similor. A golden-colored variety of brass (Ure). Also called Mannheim gold; Prince Rupert's metal.

Simple alloy steel. An alloy steel containing one alloying element, as for example, simple nickel steel (Hibbard). *See also* Ternary steel.

Simple mineral. A mineral found in nature, as distinguished from rocks, which, in the scientific sense, are mixtures of minerals (Standard). Calcite and hematite are simple minerals, while granite is a mixture of three simple minerals—quartz, feldspar, and mica.

Simple steel. A steel consisting chiefly of iron and carbon. Other elements are always present, but are not essential to the formation of the steel. The content of carbon may be very small. Often called Carbon steel.

Simple vein. A vein composed of homogeneous, not banded, material (Standard). A vein composed of one mineral, as pyrite, fluorite, hematite, etc.

Sinaite. An alliterative substitute for syenite proposed by Rozieres because on Mt. Sinai, true quartzless syenites occur, whereas at Syene the rock is a hornblende-granite. (Kemp)

Sing. A hissing noise often made by gas and water when a seam of coal is cut into. (Gresley)

Singing coal (Eng.). A bed of coal from which gas escapes with a hissing sound, particularly if the surface be wet. (Gresley)

Singing lamp (Eng.). A form of safety lamp which, when placed in an atmosphere of explosive gas, gives out a peculiar sound or note, the strength of the note varying in proportion to the percentage of fire damp present. (Gresley)

Single-bench quarrying. Quarrying a rock ledge as a single bench the full height of the quarry face. (Bowles)

Single entry. A system of opening a mine by driving a single entry only, in place of a pair of entries. The air current returns along the face of the rooms, which must be kept open. (Steel)

Single-entry room-and-pillar mining. *See* Room-and-pillar method.

Single-intake fan. A ventilating fan that takes or receives its air upon one side only. (C. and M. M. P.)

Single-jack. A light single-hand hammer used in drilling, especially in metal mines. The hammer is used in one hand while the drill is held by the other.

Single-road stall. (So. Wales). A system of working coal by narrow stalls. (Gresley)

Single-rope haulage. A system of underground haulage in which a single rope is used, the empty trip running in by gravity. Engine-plane haulage. (C. and M. M. P.)

Single shot. A charge in one drill hole only fired at one time as contrasted with a multiple shot where charges in a number of holes are fired at one time. (Bowles)

Single-stall working. *See* Room-and-pillar method.

Single stamp-mill. A lonely mill, like some to be seen in the deserts of Nevada. (Rickard)

Single-stamp mill. A mill possessing batteries of one stamp each, like the Nissen, instead of the usual five. (Rickard)

Single-stamp-mill. A mill possessing only one stamp, after the Lake Superior fashion, where one big stamp does the work of 150 ordinary gravity stamps. (Rickard)

Sink. 1. Any slight depression in the land surface, especially one having no outlet; one of the hollows in limestone regions (limestone sink) often communicating with a cavern or subterranean passage so that water running into it is lost. Also called Sink hole, Swallow hole. 2. (Corn.) A preliminary excavation or pit to be enlarged in working till it is a full-sized shaft; a sump. (Webster)
3. To excavate strata downward in a vertical line for the purpose of winning and working minerals. 4. To bore or put down a borehole. (Gresley)
5. The depression in a shaft made by a center-blast. (Standard)

Sinker. 1. (Eng.) A man who works at the bottom of a shaft when a shaft is being sunk. 2. A special movable pump used in shaft sinking. (Gresley)
3. *See* Sinker bar.

Sinker bar. A bar added to the drill tools simply to give the required force to the upward jar. It is never allowed to pound upon the drill. (Chance)

Sinker-bar guides. Bars of iron (usually 4) fitted to the drill tools in order to increase their girth and render it impossible for the drill to deviate. (Mitzakis)

Sinkers' hat (Scot.). An oilskin or leather hat used for working in falling water, as in wet shafts. (Barrowman)

Sink hole. A vertical hole worn by by water into limestone rock along a joint or fracture. Such a hole usually is connected with an underground channel. The caving in of the roof may cause more depression and the formation of a pond. The course of a joint is often marked by a row of sink holes. Called also Sink; Swallow-hole (Standard). *See* Sink, 1.

Sinking bogie (Scot.). A wheeled platform to cover a shaft while the bucket is being emptied. (Barrowman)

Sinking fire. A forge in which wrought-iron scrap or refined pig-iron is partly melted or welded together by means of a charcoal fire and a blast. (Raymond)

Sinking fund. A fund created for the purpose of paying a debt when the debt falls due. (E. B. Skinner, p. 142)

Sinking head. Same as Deadhead, 1.

Sinking-lift. A lift (pump) of small size with especially heavy castings to resist the force of blasting: used in shaft-sinking (Standard). A sinking pump, which is also sometimes called Sinker.

Sinking pit (Eng.). A shaft in course of being sunk. (Gresley)

Sinking pump. A movable pump, usually vertical, hung in a shaft, and lowered, as the shaft is deepened (Weed). Also called Sinker.

Sinkman (Scot.). Same as Sinker, 1.

Sinks (Lanc.). Natural cavities found in iron mines. *See* Sink. (Gresley)

Sinople. 1. A ferruginous clay from which the pigment sinopia is prepared. Called also Sinoper; Sinopite. 2. A ferruginous quartz from Hungary. Also spelled Sinopal. (Standard)

Sinter. 1. A chemical sediment deposited by a mineral spring, either hot or cold. Siliceous sinter, consisting of silica, is also called Geyserite and Fiorite; calcareous sinter, consisting of calcium carbonate, is also called Tufa, Travertine, and Onyx marble. (La Forge)
2. Dross of iron; cinder. 3. To become or cause to become a coherent solid mass by heating without thoroughly melting. (Webster)

Sintering man. One in charge of a plant for sintering flue dust, or simply an employee at such places. (Willcox)

Siphon. A pipe bent in the form of U or ∩ acting on the principle of the hydrostatic balance so that the pressure of water in one leg always tends to equalize that in the other.

Siphonage. The action or operation of a siphon. (Century)

Siphon separator. An apparatus for the sizing of pulverized ores in an upward current of water. (Webster)

Siphon-tap. *See* Arends' tap.

Sipylite. A columbate of erbium chiefly, also of the cerium metals and other metals. (U. S. Geol. Surv.)

Sirdar (India). A native chief; a high military officer (Webster). As used in Indian mining literature, a foreman. Also Sardar.

Sit (Eng.). To settle or subside without breaking, as a mass of coal after undercutting and removal of the props. (Standard)

Size. 1. (Eng.) The extent of the displacement or the throw of a fault. (Gresley)
2. In brickmaking, plasticity, as of tempered clay. (Standard)
3. To separate minerals according to various screen meshes.

Skail (Scot.). A quantity of air allowed to take a short cut to rejoin the main current; air finding its way into the return air course by other than the designed way (Barrowman). *See* Scale, 3.

Skailing the air. (Scot.) Brushing out the foul air by means of diverting a current of fresh air into the gaseous workings. (Ure)

Skedophyre. A porphyritic rock in which the phenocrysts are distributed more or less uniformly through the groundmass. (Iddings, Igneous Rocks, p. 224)

Skeel (Som.). A kind of bucket or tub in which coal is lowered down the cuts or staples. (Gresley)

Skeleton crystals. Hollow or imperfectly developed crystals formed by rapid crystallization. (A. F. Rogers)

Skep. 1. (Corn.) An iron box working between guides, in which ore or rock is hoisted. It is distinguished from a kibble, which hangs free in the shaft (Raymond). A skip.
2. (Eng.). A bucket or tub at a mine out of which a horse drinks. (Gresley)

Skerries (War.). Greenish-white micaceous sandstone. (Gresley)

Skerry (Prov. Eng.). A loose, irregular piece of rock; rubble. (Standard)

Skerrystone (Mid.). Hard, thin bedded sandstone. (Gresley)

Skew. An irregular discontinuous vein striking out from the principal vein in an uncertain direction, lying in a slanting and irregular position. (Power)

Skew arch. An arch whose jambs are not at right angles with the face. (Webster)

Skewback. The beveled stone, iron plate, or course of masonry that supports the spring or foot of a segmented arch. (Standard)

Skew plate. *See* Bloomery.

Skid. 1. A shoe or clog, as of iron, attached to a chain, and placed under a wheel to prevent its turning when descending a steep hill; a drag. 2. A brake for a crane. 3. A timber, bar, or rail used in pairs or sets to form a slideway or rollway, as for an incline from a truck to the ground. (Webster)
4. An arrangement upon which certain coal-cutting machines travel along the working faces. (Gresley)

Skidoo bell (Mo.). A bell placed near the bottom of a shaft to warn men of any impending danger, as of falling material, descending cage, fire, etc.

Skiffle (Scot.). A sled or small hutch (Barrowman). *See* Slype.

Skiffling. The knocking off or knobbing of the corners of building-stone in the first dressing. (Standard)

Skimmer. 1. A device on tap-hole trough next to the furnace by which slag is automatically removed or skimmed from top of iron at cast, and diverted to ladles or pit. (Willcox)
2. An iron bar for holding back the slag in pouring molten metal. (Standard)

Skimming gate. A channel in a sand-mold having over it a bridge that removes the dross from molten metal as it passes through (Standard). *See* Skimmer.

Skimming ladle. Any ladle used in skimming; specifically, a ladle used for pouring molten metal, having its lip covered with a guard to retain the dross. (Standard)

Skimmings; Skimpings (Corn.). The poorest part skimmed off the ore in a jig. (Raymond)

Skimping. Same as Jigging. *See also* Skimmings.

Skin friction. Friction between a fluid and the surface of a solid moving through it. (Webster)

Skin to skin. As close as practicable. Timbers set up so close as to be touching each other are said to be skin to skin; *e. g.*, placing timbers on each other, as laying a wall with rock or brick.

Skip. 1. A large hoisting bucket, constructed of boiler plate, which slides between guides in a shaft, the bail usually connecting at or near the bottom of the bucket so that it may be automatically dumped at the surface. 2. An open iron vehicle or car on four wheels, running on rails and used specially on inclines or in inclined shafts. Sometimes spelled Skep.
3. A thin slice taken off a breast, pillar or rib along its entire length or part of its length. Called Slab in Arkansas. (Steel)

Skipping the pillar. To take a slice off the pillar before abandoning the workings; to rob (Chance). Also widening the gangway or entry.

Skip pit. The depression into which the skip descends when at the bottom of the skip incline to bring its top below the discharge chute of the scale car or bin. (Willcox)

Skip road, or way. A track of T-rails, spiked to wooden sleepers, on which a skip runs. (Weed)

Skips (Wales). Skirtings for widening out a coal road (Redmayne). *See* Skip, 2; *also* Skirting.

Skip-shaft. A (mine) shaft especially prepared for hauling a skip. (Standard)

Skirting. A road opened up or driven next to a fall of stone or an old fallen place. (Steel)

Skit. A Cornish term for a pump. (Skinner)

Skrin; Scrin (Derb.). Cross fissures in limestone, sometimes containing small quantities of ore. (Power)

Skull. 1. A crust of solidified steel lining a Bessemer ladle. (Raymond)
2. Solidified iron, graphite, and cinder in ladles at blast furnaces. (Willcox)

Skull cracker. *See* Skull drop.

Skull drop; Skull cracker. A place where heavy ladle skulls are broken. (Willcox)

Skutterudite. An arsenide of cobalt, of gray color and brilliant metallic luster. (Chester)

Slab. 1. A split piece of timber from 2 to 3 inches thick, 4 to 6 feet long, and 7 to 14 inches wide, placed behind sets or frames of timber in shafts or levels. 2. Pieces of wood

sawed off the sides of a log. 3. A skip or slice taken off the rib of an entry or room. (Steel)
4. Cleaved or finely parallel jointed rocks, which split into tabular plates from 1 to 4 inches thick. Slabs are seldom so strong as flags. Also called Slabstone. (Power)
5. A mass of tin run into a stone mold. (Standard)

Slabbing. 1. Close timbering between sets of timber. (Duryee)
2. Lagging placed over bars. Also called Slabs. (Gresley)
3. Cutting a slice or slab from the side of a pillar. *See* Slab, 3.

Slab entry. An entry which is widened or *slabbed* to provide a working place for a second miner. (Steel)

Slabstone. A rock that readily splits into flags or slabs; flagstone. (Standard)

Slack. 1. Small coal; coal dirt. *See* Culm, 2. (Raymond)
2. The process by which soft coal disintegrates when exposed to the air and weather (Steel). Also to slake, as lime.

Slack box (Aust.). A bin in which fine coal (Slack, 1) is stored. (Power)

Slacken. In metal smelting, the scoria of previous operations, mixed with the ores to retard or prevent fusion of the nonmetallic portions. Also spelled Slakin. (Standard)

Slack wax. A name for a mixture of paraffin wax and oil. (Bacon)

Slade (Ir.). A long spade with an L-shaped blade for digging peat. (Standard)

Slag. 1. The vitreous mass separated from the fused metals in smelting ores. (Raymond)
2. To form a slag, or to cohere when heated so as to become a slag-like mass. (Century)
3. Volcanic scoria. (Standard)

Slag brick. Brick made of furnace slag.

Slag buggy (Local, U. S.). A very large pot for holding slag obtained in the smelting of ores. It is mounted on a railway truck or the like so as to permit easy dumping. (Standard)

Slag car. A two- (or four-) wheeled iron car used to carry slag from a furnace to a dumping place (Century). A slag buggy.

Slag cement. A hydraulic cement made by grinding granulated blast-furnace slag with slaked lime. (Webster)

Slag dump. A dumping place for molten slag, or for shells, or cones that form in a slag pot. (Standard)

Slag furnace. A furnace designed for extracting lead from slags.

Slaggable. Capable of becoming, or forming into, a slag.

Slaggy. 1. Pertaining to, containing, or of the nature of slag; as, a *slaggy* substance. 2. Of slaggy structure; said of rocks composed of intermingled roughly cellular and compact portions, like slag from an iron furnace. (Standard)

Slag hearth. A hearth, on the principle of the Scotch hearth, for the treatment of slags, etc., produced by lead smelting in the reverberatory furnace. The English slag hearth has one tuyère; the Castilian or Spanish three. (Raymond)

Slag-lead. Lead obtained by a re-smelting of gray slag. (Raymond)

Slag notch. *See* Cinder tap.

Slag pot. A vessel for the disposal of slag at furnaces. Small pots are mounted on wheels and handled by hand, while the larger ones are mounted on trucks for mechanical transportation. (Hofman, p. 258). *See* Slag buggy; Slag car.

Slag shingle. Broken slag used in road-building. (Standard)

Slag wool. A finely fibrous mass produced by blowing steam or air into molten slag (Raymond). Same as Mineral wool.

Slake. 1. To become slack or loose.
2. To become mixed with water, so that a true chemical combination takes place, as in the slaking of lime. (Webster)
3. (Scot.) A glutinous silt adhering to the sides of deep boreholes especially in passing through fine sandstone. (Barrowman)

Slake trough. A blacksmith's water tank for cooling forgings or tools. (Webster)

Slakin. *See* Slacken.

Slant. 1. Any short inclined crosscut connecting the entry with its air course to facilitate the hauling of coal. Commonly called a Dip-switch when the coal is not level. Also

called Shoo-fly. (Steel) 2. A heading driven diagonally between the dip and the strike of a coal seam; also called a Run. *See* Counter, 2. (Raymond)

Slant chutes. Chutes driven diagonally across to connect a breast manway with a manway chute. (Chance) *See* Slant, 2.

Slap (Som.). Slack coal. (Gresley)

Slash (Eng.) A mass of coal crushed and shattered by a movement of the earth's crust. (Century)

Slasher. In brickmaking, a wide sword-like implement for slicing masses of clay in search of stones and roots. (Standard)

Slat. 1. A thin piece of slate, as for roofing. 2. A flat piece of stone used in veneering masonry. Also spelled Slatt. 3. (Prov. Eng.) Dark-blue ooze, rather hard, left dry by the ebb of the sea. (Standard)

Slate. A dense, fine-textured metamorphic rock whose separate minerals are indistinguishable to the unaided eye, and which has an excellent parallel cleavage, so that it breaks into thin plates or pencil-like shapes (U. S. Geol. Surv.) *Compare* Shale.
A coal miner's term for *any* shale or slate accompanying coal; also sometimes applied to bony coal.

Slate cement. 1. A cement made with slate; a kind of hydraulic cement. 2. A mixture of broken slate and tar or asphalt, used as a roofing material. (Webster)

Slate chute. 1. A chute for the passage of slate and bony coal to the pocket from which it is loaded into dump cars. 2. A chute driven through slate. (Chance)

Slate clay. 1. Shale. 2. A fire clay occurring among coal beds. (Standard)

Slate coal. 1. (Eng.) A hard, dull variety of coal. (Gresley)
2. Coal that has pieces of slate of greater or less size attached to it, which can be separated by breaking the coal into smaller pieces and subjecting the coal to a washing process. (Power)

Slate fault. A local replacement of a coal seam by slate; a simple thickening of a regular slate parting is also often designated by the same term, or is called a "horse." (Chance)

Slate picker. 1. A man or boy who picks the slate and bony coal from the coal. 2. A segment of a cylindrical screen provided with narrow slits, through which the flat pieces of slate fall, but through which the coal (not being flat) can not pass. (Chance)

Slate spar. A variety of crystallized calcite. Called also Shiver spar. (Standard)

Slat gate. A gate, for controlling water, composed of two upright grooved posts with boards between, the boards or slats being removed or added to regulate the height of water. (Clennell, p. 177)

Slaty. Characteristic of, pertaining to, resembling, or consisting of slate; having the characteristic cleavage and texture of slate. (La Forge)

Slaty cleavage. A tendency to split into thin, smooth, even plates, like slate, the more typical if the planes of cleavage are transverse to the bedding-planes. (Standard)

Slawm (Derb.). A rock joint filled with moist clay (Hooson). Also Slaum, Sloam, Sloom.

Slazburg vitriol. A mixture of copper sulphate and ferrous sulphate crystallized together about in the proportion of 1:3. (Webster)

Sleck. 1. (Newc.) Mud deposited by water in a mine. (Raymond)
2. (Eng.) A kind of reddish sandstone. (Webster)

Sled. A drag used to convey coal along the road to where it is loaded into cars, or to the chute (C. and M. M. P.). Also called Sledge; Slype.

Sleek. 1. Having an even, smooth surface; slick. (Webster)
2. (Brist.) Soft and troublesome, as applied to the condition of the floor in steep seams. (Gresley)

Sleeping rent. A fixed rent stated in leases of coal mines, as distinguished from royalty or share of profits. (Standard)

Sleeping-table (Corn.). A stationary buddle. For the strict distinction sometimes made between buddle and table, *see* Buddle. (Raymond)

Sleeve. A piece of pipe or thimble for covering a joint, or for coupling two lengths of piping. (Webster)

Slew (Derb.). A basin or swamp; a wet marshy place. *See* Lum, 2. (Gresley)

Slice. 1. A thin, broad piece cut off, as a portion of ore cut from a pillar or face. 2. To remove ore by successive slices. 3. A gem-slitting mill. (Standard)

Slice bar. A thin, wide iron tool for cleaning clinkers from the grate-bars of a furnace. (Standard)

Slicer. A lapidary's slitting mill. (Standard)

Slicker. A small implement used in a foundry for smoothing the surface of a mold. (Standard)

Slicing and filling system. *See* Overhand stoping.

Slicing machine. An upright pug mill, with radial blades, for slicing clay in the manufacture of pottery. (Standard)

Slicing under mats of timber in panels. *See* Top slicing and cover caving.

Slicing under ore with back caving in rooms. *See* Top slicing combined with ore caving.

Slick. Ore in a state of fine subdivision; synonymous with Slimes (Duryee). Also called Slickens.

Slickens (Cal.). A word sometimes used to designate the débris, or tailings, discharged from the hydraulic mines or from stamp mills. (Hanks)

Slickenside. A polished and sometimes striated surface on the walls of a vein, or on interior joints of the vein material or of rock masses. (Raymond) Produced by rubbing during faulting, on the sides of fissures or on bedding-planes. (La Forge) Also called Slicks.

Slicking. A narrow vein of ore. (Standard)

Slicks (Eng.). Smooth partings or mere planes of division in strata (Gresley). Slickensides.

Slide. 1. (Corn.) A vein of clay intersecting and dislocating a vein vertically; or the vertical dislocation itself. 2. An upright rail fixed in a shaft with corresponding grooves for steadying the cages. *See* Guide. (Raymond)
3. The descent of a mass of earth or rock down a hill or mountain side. 4. The track of bare rock left by a landslide. (Webster)
5. An accumulation of loose gravel and detached bowlders washed down from the mountains. (Colo. Central, etc., Mining Co. *v.* Turck, 50 Fed. Rept., p. 890)
6. A small dislocation in a rock mass. (Standard)

Slide joint. A connection acting in rod-boring like the jars in rope-boring. (Raymond)

Slide rule. An instrument, consisting in its simple form of a ruler with a medial slide, ruler and slide being graduated with logarithmic scales which are labeled with the corresponding antilogarithms. The graphic addition upon the slide and rule of two divisions of the scale, gives the product their antilogarithms. (Webster)

Sliding scale. 1. A mode of regulating the wages paid working men by taking, as a basis for calculation, the market price of coal (or other product). The wages rise and fall with the condition of trade, or markets. 2. (Ark.) A method of paying for the coal in proportion to the amount of lump coal it contains. (Steel)

Sliding suction (Scot.). A suction pipe capable of being lengthened by telescopic arrangement. (Barrowman)

Sliding the rail. Said of a driver when he places one foot on the rail in front of the car, and the other foot on the bumper, and with his right hand holds on to the car and allows his foot to slide on the rail. (Marquette Third Vein Coal Co. *v.* Allison, 132 Illinois App., p. 232)

Sliding windbore (Eng.). The bottom pipe or suction-piece of pumps used in shaft sinking, having a lining made to slide or telescope within it, to give length without altering the adjustment of the whole column of pumps (Gresley). Also called Sliding suction.

Slig; Sliggeen (Ir.). Shale. (Power)

Slime. A product of wet crushing containing valuable ore in particles so fine as to be carried in suspension by water; chiefly used in the plural (Webster) In metallurgy, ore reduced to a very fine powder and held in suspension in water so as to form a kind of thin ore-mud; generally used in the plural. (Century)

Slime-box. *See* Slime-pit.

Slime-pit. A tank or large reservoir of any kind into which the slimes are conducted in order that they may have time to settle, or in which they may be reserved for subsequent treatment. *See* Slime. (Century)

Slimer. A machine that makes slime; for example, a tube mill. (Rickard)

Slime sludge. 1. The pulp or fine mud from a drill hole. 2. *See* Slime.

Slime table. A table for the treatment of slime. A buddle.

Slime washer. A vanner, concentrator, or similar machine, used in the separation of ores. (Standard)

Slime water. Water defiled in washing ore. (Standard)

Sline. 1. Natural transverse cleavage of rock (Raymond). A joint.
2. (Mid.). Pot holes in a mine roof. (Gresley)

Sline back. A joint or crevice that bounds a block of rock in the roof, as the upper surface of a pot hole or kettle bottom.

Sling. 1. In ceramics, a piece of wire with a handle at each end for cutting clay. 2. To cut clay with a sling. (Webster)
3. A rope or chain put around stones or heavy weights for raising them. C. and M. M. P.)

Sling cart. A kind of cart to transport large stones, machines, etc., the load being suspended by chains attached to the axle. (Webster)

Sling chain (Scot.). A chain by which pump pipes are suspended. (Barrowman)

Sling psychrometer. An instrument consisting of a pair of thermometers, provided with a handle, which permits the thermometers to be whirled rapidly, the bulbs being thereby strongly affected by the temperature of and moisture in the air. The bulb of the lower of the two thermometers is covered with thin muslin, which is wet at the time an observation is made. Used for determining humidity of the air. (Liddell)

Slink (Scot.). A wide clayey joint; a stage. (Barrowman)

Slip. 1. A fault. 2. A smooth joint or crack where the strata have moved upon each other. 3. (Ark.) A joint in the coal upon which there may have been no preceptible movement. (Steel)
4. The relative displacement of formerly adjacent points on opposite sides of the fault, measured in the fault surface. *See* Dip slip and Strike slip. (Lindgren, p. 119)
5. A sudden descent of a hanging or sticking charge in a blast furnace. (Willcox)
6. Potter's clay in a very liquid state used for the decoration of ceramic ware, or as a cement for handles or other applied parts. To convert into slip. (Webster)
7. Same as a horseback, kettleback, or kettlebottom. (Davis *v.* Nuttallsburg Coal & Coke Co., 34 West Virginia, p. 502; Cons. Coal Co. *v.* Scheller, 42 Illinois App., p. 621)

Slip clay. An easily fusible clay, sometimes used to make a natural glaze on the surface of clay wares. (Ries)

Slip cleavage. 1. Microscopic folding and fracture accompanied by slippage; quarrymen's "false cleavage." (Ries)
2. (So. Wales). The cleat of the coal in planes parallel with slips or faults. (Gresley)

Slip-decoration. Decoration on ceramic ware made by applying slip or barbotine with a small pipe. (Standard)

Slip-dike (Scot.). A whin dike accompanied by a dislocation of the strata; a fault. (Barrowman)

Slipes (So. Staff.). Sledge-runners, upon which a skip is dragged from the working breast to the tramway. (Raymond)

Slip-glaze. 1. A pottery glaze composed of a fine clay or similar mineral powder: applied mixed with water. (Standard)
2. A glaze produced with slip-clay, *which see.* (Ries)

Slip-hook. A hook, generally on a hinge, which can be readily disconnected by withdrawing a cotter bolt that holds it in position. (Power)

Slip-kiln. A kiln consisting of a series of pans for drying potters' slip. (Standard)

Slippy (Eng.). Abounding in cracks or joints; said of rocks in the Midland coal field. (Standard)

Slippy backs (No. of Eng.). Vertical planes of cleavage occurring every four or five inches in the seam of coal. Also called Slip things. (Gresley)

Slip-spear. A tool for extracting tubing from a bore-hole. (Gresley)

Slip-strainer. A strainer through which potter's slip is passed. (Century).

Slip-things (So. Staff.). The more or less vertical planes of cleavage in coal. *See* Slippy backs. (Gresley)

Slip-trouble (Scot.). Difficulties encountered in mining due to slips. *See* Slip, 1.

Slip-vein. A mineral vein accompanied by faulting or dislocation. (Skinner)

Slit. A communication between two levels. (Raymond).

Slitter (Eng.). A pick. (Gresley)

Slitting-disc. A gem-cutter's slitting-mill.

Slitting-mill. A rotating disc used by gem-cutters in slitting; a slicer. (Standard)

Sliver (Eng.). A thin wooden strip, inserted into grooves in the adjacent edges of two boards of a brattice, to make it air-tight. (Raymond)

Sloam. A layer of clay between seams of coal (Standard). Also Sloom.

Slob (Eng.). Mud; a marsh or mire. (Century)

Slocking stone (Eng.). A piece of rich ore used to tempt persons into a mining enterprise (Webster). *See* Salting a mine.

Sloom (Mid.). A soft, earthy, clay or shale often underlying a bed of coal (Gresley). Also Sloam; Slawn.

Slop. In ceramics, to blend thoroughly, as clay, by kneading, or cutting and piling. (Standard)

Slop brick. A name sometimes applied to soft-mud brick. (Ries)

Slope. An inclined passage driven from the dip of a coal vein. *Compare* Slant, 2. When not open at one end to the surface, it is known as an *inside slope. See also* Incline; Plane. *Rock slope:* A slope driven through rock strata. *Slope air-course:* A passageway parallel to the haulage slope used for the passage of the air current. (Steel).

Slope cage; Slope carriage. A truck on which the cars are raised at slopes or steep dips. (Chance)

Slope dook (Scot.). An incline driven not direct to the dip, *i. e.*, intermediate between the dip and strike. (Barrowman). *Compare* Slant, 2.

Slope heading (Scot.). A heading driven not direct to the rise (Barrowman). The opposite of Slope dook.

Slope mine. A mine opened by a slope or incline.

Slope road (Scot.). A road driven at an angle less than a right angle with level course. *See* Slope dook. (Barrowman)

Sloping pump (Scot.). A hand pump laid on the slope of the strata to drain dip workings. (Barrowman)

Slop-molding. A method of molding bricks in open-topped boxes or molds previously dipped in water to keep the clay from sticking to them; distinguished from Pallet-molding. (Standard)

Slop oil. Any liquid product of petroleum which is not up to quality. Slop oils are usually put aside for redistillation. (Bacon)

Slopping. In ceramics, a process of kneading clay to render it homogeneous. (Standard)

Slot (York.). To hole (Gresley). To undercut or channel.

Slottere (Corn.). Dirty; muddy; slovenly. (Pryce)

Slotting (York.). Coal cut away in the process of holing. Often used in the plural (Gresley). Sometimes called Bug-dust in the United States.

Slovan (Corn.). 1. The outcrop or back of a lode. This generally applies to the appearance of a lode in a marshy place. N. B.—*cropping out* is a Welsh, also East and North of England, term; but is never used in Cornwall. (Hunt)
2. A gallery in a mine; day level: especially applied to damp places. (Standard)

Sludge. 1. A term applied to the tar from the agitators in the chemical treatment of distillates. 2. Soft mud; muddy sediment in steam boilers; slime resulting from ore dressing. (Webster)
3. The fine mixture of water and bore meal produced by the action of a drill in a rock. 4. Refuse from a

coal-washing plant. 5. A device for pumping sludge from a bore hole; a sand pump or shell pump. (Standard)
6. Sometimes synonymous with Slime.

Sludge acid. Impure and dark-colored sulphuric acid that has been used in refining petroleum. (Webster)

Sludge channel. A tail race for conveying the tailings away after the gold has been extracted from alluvial beds. (Duryee)

Sludge door. An opening through which sediment may be moved. (Century)

Sludge mill. A machine in which the sludge (slime) from another mill is washed (Duryee). As, for example, a Slime table.

Sludge pump. A short iron pipe or tube fitted with a valve at the lower end, with which the sludge is extracted from a bore-hole. (Gresley)

Sludger. A cylinder having an upward-opening valve at the bottom, to pump out the sludge or fine rock resulting from drilling (Ihlseng). A Sand pump; a Sludge pump.

Slue. To turn or twist about. To slip or slide out of course (Webster). In cutting the coal, the machine moves from right to left, the back part moving faster than the front. It is necessary at intervals to stop the machine and straighten it, or "slue" it, as called by miners. (Consolidation Coal Co. *v.* Bailey, 198 S. W. Rept., p. 562)

Slug. 1. A lump of metal or valuable mineral, *e. g.*, Cassiterite or Cerargyrite. (Power)
2. A mass of half-roasted ore. (Webster)
3. (Eng.) A loop formed at the end of a rope through which a miner passes his leg previously to descending an old shaft or working. (Hunt)

Slugga. (Irish) A hole in the surface rock of some limestone formations, caused by the falling in of parts of the crust over subterranean streams (Standard). *Compare* Sink; Sink-hole.

Slugger. A projection on the face of a crushing roll. (Richards, p. 105)

Sluice. 1. A long, inclined trough, launder, or flume, usually on the ground, for washing auriferous earth, floating down logs, etc. In gold mining such a contrivance is paved with riffles, etc., to hold the quicksilver for catching the gold. 2. To wash with or in a stream of water running through a sluice. 3. To scour out, as a channel, by means of a flood of water. (Webster)

Sluice box. A wooden trough in which alluvial beds are washed for the recovery of gold or tinstone. (Cox)

Sluice fork. A form of fork having many tines, used to remove obstructions from a sluiceway. (Century)

Sluice gate. The sliding gate of a sluice. (Webster)

Sluice head (Aust.). A supply of 1 cubic foot of water per second, regardless of the head, pressure, or size of orifice (C. and M. M. P.). *Compare* Miner's inch.

Sluice valve. A sluice gate. (Webster)

Sluiceway. An artificial channel into which water is let by a sluice. (Webster)

Sluicing. Washing auriferous earth through long races or boxes, provided with riffles and other gold saving appliances, and so-called sluices. (Hanks)

Sluicing table (New Zealand). A table, on wheels, used for washing black sand for its gold content. (Duryee)

Slum; Slums. 1. (No. Staff.) A black slippery, indurated clay. 2. A soft clayey or shaley bed of coal (Gresley). Also spelled Slumb.
3. Used in the plural for the discharge or waste from hydraulic mines. *See* Tailing, and Slime. (Hanks)

Slumgullion. A muddy, usually red, deposit in the sluices. (Webster)

Slurry. 1. A thin watery mud, or any substance resembling it. 2. A thin cement or mortar used to repair furnace linings. 3. A watery mixture of the powdered raw materials of hydraulic cement. 4. A wash used by molders. (Webster)
5. (Eng.) A mixture of sulphides and arsenides of copper, lead, and silver, etc., resulting from silver-smelting. (Standard)

Slush. 1. To fill in with mortar, cement, or the like, as the joints of a wall. (Webster)
2. To fill mine workings with sand, culm, etc., by hydraulic methods. *See* Hydraulic mine-filling.

Slushing. A synonym for Hydraulic mine-filling. (U. S. Bu. Mines, bull. 60)

Slyne. *See* Sline.

Slype (Scot.). A sled for drawing coal along the wall face, or in steep workings (Barrowman). Also called Sawney.

Small (Eng.). A term frequently used for slack or fine coal. (Gresley)

Small bottom. A local term used at Jenny Lind, Arkansas, for the smaller part of the bottom bench of the coal seam. This is below the *top bottom* and separated from it by a smooth seam. (Steel)

Small butty (Staff.). A contractor who engages to work a certain part of a seam—usually reckoned as a certain width of face—at a tonnage price, the contractor finding and paying the labor necessary to mine and deliver the coal to the haulage road. (Redmayne)

Small coal. 1. Coal broken into small pieces, usually that smaller than stove size; slack. (Standard) 2. Thin seams of coal; also called Low coal.

Small ore (Eng.). Copper, lead and zinc ore dressed to a small size (Hunt). Also called Smalls.

Smalls. 1. Small coal; slack. 2. Small particles of mixed ore and gangue (Standard). *See* Small ore.

Small tin (Eng.). Tin recovered from slimes. (Hunt)

Smalt. A blue pigment or glass, consisting of silica, potash, and cobalt. (Raymond)

Smaltine. An arsenide of cobalt, often containing nickel and iron. Also called Smaltite, Gray cobalt, Tin-white cobalt. (Century)

Smaltite. Cobalt diarsenide, $CoAs_2$. Contains, when pure, 28.2 per cent cobalt. Through replacement of the cobalt by nickel it grades into chloanthite, the nickel arsenide, $NiAs_2$. (U. S. Geol. Surv.)

Smaragd. A precious stone of light green color; a variety of beryl. (Dana)

Smaragdite. A thin-foliated variety of amphibole, near actinolite in composition but carrying some alumina. It has a light green color, resembling much common green diallage. (Dana)

Smart fire (No. of Eng.). A severe, though small, mine explosion. (Gresley)

Smart money (No. of Eng.). A weekly allowance of money given by employers to workmen who are injured while at work (Gresley). Accident compensation.

Smear. 1. A volatile flux for glazing ware. 2. To give a luster to (articles of pottery) without glazing, as by putting a volatile flux in the kiln with the ware (Standard). Also spelled Smeir.

Smectite. 1. A green clay. (Standard) 2. A greenish variety of halloysite. In certain states of humidity appears transparent and almost gelatinous. (Dana)

Smeddum. 1. (Scot.). The smaller particles of ore which pass through the sieve of the hutch. (Raymond) 2. (Eng.). Clay or shale separating coal seams. (Webster) 3. Fine coal-slack. (Standard) Also spelled, Smiddam, Smiddum, Smitham, Smithem, Smitten and Smytham.

Smeir. A semiglaze used on pottery; a mixture of common salt and slip glaze. *See also* Smear.

Smelt. 1. To reduce metals from their ores by a process that includes fusion. In its restricted sense *smelting* is confined to a single operation, as the fusion of an iron ore in a shaft furnace, the reduction of a copper matte in a reverberatory furnace, and the extraction of a metal from sweepings in a crucible; but in its general sense it includes the entire treatment of the material from the crude ore to the finished metal, and embraces: (a) the calcination or roasting, by means of which the sulphur and other volatile constituents are expelled; (b) The reduction of the resulting furnace products, or the smelting proper, and (c) the refining of the product from the second operation. 2. To melt or fuse as a metal. (Standard)

Smelter. 1. One who is engaged in smelting or who works in an establishment where ores are smelted. 2. In the United States, smelting works; an establishment where ores are smelted (Century). Also, more correctly called Smeltery.

Smeltered (Calif.). A term applied to animals that have been injured by smelter fumes, either by inhalation or by eating vegetation upon which smelter fumes have settled. (U. S. Bu. Mines, bull. 98, p. 54)

Smelters' ton. A long ton plus an allowance for sandage, etc. (Standard)

Smeltery. A smelting establishment (Webster). Better usage than smelter, 2.

Smelting furnace. A blast furnace, reverberatory furnace, or other furnace in which ore is smelted for the separation of a metal. (Standard)

Smelting house. A structure built over a smelting-furnace; a smelting works (Standard). A smeltery.

Smelting works. An establishment in which metals are extracted from ores by furnaces. (Standard) A smeltery.

Smiddam; Smitham (Derb.). Lead-ore dust (Raymond). A variation of Smeddum, 1.

Smiddum (Eng.). A variation of Smeddum. (Webster)

Smiddum tails (No. Eng. and Scot.). Ore sludge; ore slime (Standard). A variation of Smeddum.

Smiddy coal (Scot.). Smithy coal. (Barrowman)

Smift (Eng.). A fuse or slow match. (Raymond)

Smitham; Smithem; Smytham. 1. (Mid.) Fine slack. 2. Clay or shale between two beds of coal (Gresley) A variation of Smeddum, 2 and 3.

Smithery. 1. The art of shaping or fashioning, as iron or steel, with a hammer and other tools; smithing. 2. A smith's shop; smithy. (Standard)

Smith process. A variation of the series system of copper refining in which the plates are placed horizontally, the top surface of each one acting as cathode, the lower as anode. Linen diaphragms must be placed between the plates to catch the slime. When these diaphragms break and allow the slime to drop on the cathode, it is difficult to remedy any short circuits without dismantling the tank. (Liddell)

Smithsonite. Carbonate of zinc, $ZnCO_3$. (Contains 52 per cent zinc. (U. S. Geol. Surv.)

Smithy coal (Eng.). A grade of small coal habitually used by blacksmiths (Century)

Smithy ore (No. of Eng.). A soft variety of hematite, much used for forming bottoms of puddling furnaces. (Power)

Smitten. Fine gravel-like ore, occurring free in mud openings, or derived from the breaking of the ore in blasting (C. and M. M. P.). A variation of Smeddum, 1.

Smoke. The exhalation, visible vapor, or material that escapes or is expelled from a burning substance during combustion; applied especially to the volatile matter expelled from wood, coal, peat, etc., together with the solid matter which is carried off in suspension with it. That which is expelled from metallic substances is generally called Fume or Fumes (Century). *See* Fume, 2; *also* Metallurgical smoke.

Smokeless gunpowder. A gunpowder making very little smoke when exploded (Standard). *See* Smokeless powder.

Smokeless powder. An explosive consisting mainly of nitrocellulose in a more or less completely gelatinized condition. Sporting powders usually contain besides nitrocellulose, considerable foreign substances, as barium nitrate, ammonium bichromate, etc., which facilitates the combustion without increasing too much the gas pressure in the firearm. (Brunswig, p. 242)

Smoke room. 1. (Ark.) An entry air-course driven room width. (Steel) 2. A room specially constructed in which noxious gases may be generated and confined for the purpose of testing breathing apparatus.

Smoke-shade. A scale of tints, ranging from 0 to 10, used for comparison of the smoke of different varieties of coal, which are graded according to the amount of unconsumed carbon contained in their smoke, the lightest color indicating the most complete combustion. (Standard)

Smokestone. Smoky quartz. (Webster)

Smoke washer. A device in which smoke is exhausted upwards against a downward spray of water to remove the solid particles in the smoke. (Webster)

Smoke zone. The area surrounding a smelting plant in which the smoke or fumes damage vegetation, or in which it may be classed as a public menace or nuisance. (Bu. Mines, Bull. 98, p. 28)

Smoky pit (Mid.). An upcast shaft with a furnace at the bottom of it. (Gresley)

Smoky quartz. A smoky, brown-colored crystalline variety of quartz. Cairngorm. (Power)

Smoky topaz. A smoky quartz used for jewelry. (Webster)

Smooth (Wales). **1. The line of face,** as of a stall or room. **2.** A plane of cleavage more or less vertical. (Gresley)

Smooth-head (York.). **A smooth plane** of cleavage. *See* Bright-head. (Gresley)

Smoothing mill. A lapidary's polishing wheel. (Standard)

Smored (Scot.). **Obstructed with rubbish, mud, or silt, as the suction pipe** of a pump. (Barrowman)

Smother kiln. A kiln in which the smoke is smothered to blacken the pottery within. (Standard)

Smudge coal. Coal partly deprived of its bitumen, and converted into a sort of natural coke. (Power)

Smut (So. Staff.). **Bad, soft coal, containing much earthy matter.** *See* Blossom. (Raymond)

Smuth, or Musks (Eng.). **Very inferior coal** (Gresley). **A variation of smut.**

Smythe producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 313)

Snab (Scot.). **The brow of a steep** road; a short and steep part of an incline. (Barrowman)

Snake hole. A bore-hole driven horizontally or nearly so and approximately on a level with the quarry floor; **also a bore-hole driven under** a bowlder for containing a charge of explosives. In quarry work it is called a "lifter." (Du Pont)

Snakestone. A spotted whetstone from Ayr. *See* Ayr stone. (Power)

Snap. 1. (Mid.) Lunch. *See* Bait. 2. (Mid.) A haulage clip. (Gresley) Used in plural form. 3. (Eng.) A small, flat, pointed pick for chipping off brasses, stone, or slate from lump coal. (G. C. Greenwell)

Snapper. A car coupler; trip rider.

Snapping time (Mid.). **A short period of rest during a shift in which a miner takes his lunch.** (Gresley)

Snatch (Eng.). A small chimney used for ventilation. (Bainbridge)

Sneck. 1. (Scot.) An appliance for diverting wagons, or cars, from the main line into a siding. (Gresley) **2.** A latch or catch of a door. **3.** To lay rubble masonry with spalls and fragments to fill the interstices. (Webster)

Snecked rubble. Bonded rubble masonry. (Standard)

Snecking. In masonry, rubble-work. (Standard)

Snecky (Eng.). A wedge-shaped vertical cut at the end of a stall or room. (Gresley)

Snibble (Scot.). A sprag or drag for hutches, wagons, or cars. (Barrowman)

Snoff (Corn.). A short candle end, put under a fuse to light it (Raymond). A variation of Snuff.

Snore hole. The hole in the lower part or windbore of a mining pump, to admit the water. (Raymond)

Snore piece. The lowest end of a pump set through which the water passes (Gresley). An intake; a Suction pipe.

Snort valve. A butterfly valve opening from the cold-blast main of a blast furnace to the atmosphere. Allows casting at the furnace without shutting down the blowing engines. Operated by large wheel or lever in cast house. (Willcox)

Snowbird mine (or Shipper). A mine that produces or ships only small quantities of coal, and operates only when coal is high by reason of a scarcity or a shortage of cars for shipment. The coal is loaded from wagons or trucks into cars on sidings. No tipple is used. (Baltimore & Ohio R. R. Co. *v.* Public Service Commission (W. Va.), 94 S. E. Rept., p. 547)

Snowshed (Mo.) A shed or structure of heavy timber for the purpose of protecting the tub hookers and other workmen on the station floor (in a mine) from stone and débris falling from the cans while being hoisted. (Reidnour *v.* Wilcox Mines Co., 147, S. W. Rept., p. 852)

Snub. 1. To increase the height of an undercut by means of explosives or otherwise. 2. To check the descent of a car, by a turn of a rope around a post. (C. and M. M. P.)

Snubbing. 1. (N. Y. and Pa.) A term applied by bluestone quarrymen to the process of forcing a cross break in the absence of an open seam. (Bowles)
2. Increasing the height of an undercut by picking or blasting down the coal, just above the undercut.

Soak (Aust.). A natural receptacle for conserving water drained off rocky mounds. (Power)

Soaking pit. A chamber lined with refractory nonconducting material, in which white-hot steel ingots are placed and kept until the proper temperature for rolling is reached. (Standard)

Soak pit. A pit in which wet clay is allowed to soak preparatory to molding. (Ries)

Soams (No. of Eng.). A pair of cords about 3 feet in length, by which boys pull tubs along the roads (Gresley). A draft rope or chain.

Soapy heads (Eng.). The joints of stones, which are filled with a saponaceous or talc-like mineral. (Pryce)

Soap-rock. A synonym for Soapstone. (Chester)

Soapstone. 1. A metamorphic rock of massive, schistose, or interlocking fibrous texture and soft unctuous feel, composed essentially of steatite or talc, which is regarded as secondary after some ferro-magnesian mineral. 2. As used loosely by miners, well drillers, and others, any soft unctuous rock, such as micaceous shale or sericitic schist. (La Forge)

Sobarbo (Sp.). 1. A cam. 2. A tappet of a stamp mill. (Halse)

Sobrante (Sp.). Residue, overplus, surplus, profit. (Hanks)

Sobresabana (Colom.). Ore lying higher than the *sabana.* (Halse)

Sobrestante (Mex.). Overseer, foreman, or shift boss. (Halse)

Socabón (Sp.). An adit. *See* Socavón. (Halse)

Socavado (Sp.). An undercut, as in coal mining. (Halse)

Socavadora (Sp.). A coal cutter; a coal-cutting machine. (Halse)

Socavadura (Sp.). Undercutting, as in coal mining. (Halse)

Socavón (Mex.). 1. A mining tunnel. An adit level; *S. á hilo de veta,* a drift; *S. crucero,* a cross cut. (Dwight)
2. In Mexico, any gallery, the mouth of which is at the surface.
3. *Socavones,* large holes, pits, or shafts. (Halse)

Sociedad (Sp.). Society, corporation, company, partnership; *S. anónima,* a joint stock company; a limited liability company; *S. incorporada,* a chartered company. (Halse)

Socket. 1. A device fastened to the end of a rope by means of which the rope may be attached to its load; the socket may be opened and closed. (C. M. P.)
2. (Eng.) The innermost end of a shot hole not blown away after firing. (Gresley)
3. A hollow tool for grasping and lifting tools that have been dropped in a well-boring. (Standard)

Socketing. Same as Springing, 2, which *see.* Du Pont)

Soda. The normal carbonate of sodium, Na_2CO_3; soda ash: the latter being the common name of the commercial article used in chemical industries.

Soda-alum. An alum of aluminum and sodium, sometimes found native as mendozite. (Standard)

Soda-ash. Commercial anhydrous sodium carbonate. Used extensively in manufacturing trades; also as a flux, etc.

Soda-ball. Same as Black ash. (Standard)

Soda feldspar. *See* Albite.

Soda granite. *See* Natron-granite.

Sodalite. A silicate of sodium and aluminum with some chlorine. $Na_4(AlCl)Al_2(SiO_4)_3$. (Dana)

Soda nitre. Sodium nitrate, $NaNO_3$. (Dana)

Soda-orthoclase. A variety of orthoclase containing more or less sodium; also called Natron-orthoclase. (La Forge)

Sodium. A soft, waxy, silver-white metallic element of the alkali group. Symbol, Na; atomic weight 23.00; specific gravity, 0.97. (Webster)

Sods (Leic.). Clay beneath coal seams. (Gresley)

Soffioni. An emanation, from the earth, of vapors which are principally boric acid; also, the opening from which the vapors issue. *See* Solfatara, Fumarole, and Mofette.

Sofocado (Mex.). Said of a mine which has been abandoned on account of being drowned out, or from other causes. (Halse)

Soft. 1. Tender; friable; or full of slips and joints. (Gresley) 2. Bituminous as opposed to anthracitic; said of coal. (Century)

Soft air (Scot.). A stagnant state of the ventilation. (Barrowman)

Soften. To heat ore so that the minerals are cracked and fissured, permitting of easier crushing. (Richards, p. 9)

Softening. Of lead, the removal of antimony and other impurities. (Raymond)

Soft ground. Heavy ground. Rock about underground openings that does not stand well and requires heavy timbering. (Weed)

Soft-mud process. A method of molding brick, by forcing clay into wooden molds. (Ries)

Soft ore (Lake Superior). A soft or incoherent hematite, as opposed to the hard specular variety.

Soft phosphate. A term used in Florida which is applied arbitrarily to anything phosphatic that is not distinctly *hard rock.* (Power)

Soft pitch. Pitch showing a penetration of more than 10. (Bacon)

Soft pottery. Pottery, the surface of which is unglazed and easily scratched by a sharp-pointed piece of iron. (Standard)

Softs (Mid.). Coal which breaks easily. (Gresley)

Soft seat (Eng.). Fire clay found under coal seams. (Power)

Soft solder. Solder melting below a red heat; used in tinning, plumbing, etc. (Standard). Usually a tin-lead alloy, which melts at a lower temperature than either the tin or lead.

Soft steel. *See* Mild steel.

Soga (Mex.). A rope or thick cord; a cable for hoisting. (Dwight)

Soggendalite. A name proposed by C. F. Kolderup for a variety of diabase that is especially rich in pyroxene and that is intermediate between true diabases and pyroxenites. The type rock forms a dike near Soggendal, Norway. (Kemp)

Soguilla (Sp.). A small rope for hoisting ore, water, etc.

Soil. 1. Broadly and loosely, the regolith, or blanket of unconsolidated rock material that lies on the bedrock. 2. More precisely, the earthy or sandy layer, ranging in thickness from a few inches to several feet, composed of finely divided rock débris, of whatever origin, mixed with decomposing vegetal and animal matter, which nearly everywhere forms the surface of the ground and in which plants grow or may grow. (La Forge)

Soil cap. The earthy material that often covers naturally the rock. (Standard)

Sol (Colom.). A vein showing fragments of ore at the surface of the ground. (Halse)

Solapa (Colom.). A bituminous schist. (Halse)

Solar. A colloquialism among surveyors to mean an observation on the sun.

Solar compass. A surveyor's compass having a solar attachment. (Webster)

Solar oil. 1. A name given to gas oil from petroleum of the Gulf or Mid-Continent field. 2. A Russian petroleum product possessing a specific gravity above 0.850, but not exceeding 0.880, and a flash-point not below 80° C. It is usually of a very pale yellowish color. 3. Illuminating oil derived from shale. (Bacon)

Solar salt. A coarse salt obtained from brines by solar evaporation. (Standard)

Solayo (Mex.). A cutting-in hole. (Dwight)

Solder. A metal or alloy used to unite adjacent surfaces of less fusible metals or alloys. Soft solder is a compound of tin and lead; hard solder, of copper and zinc, or tin and antimony; gold solder, of gold, silver, and copper; silver solder, of silver and copper, or silver and brass; and so on. (Raymond)

Soldier sprag (N. S. W.) A long sprag used to support the coal seam by placing the upper end of the sprag in the face of the coal between the top of the holing and the roof. (Webster)

Sole. 1. The bottom of a level. 2. The bottom of a reverberatory furnace. (Raymond)
3. (Eng.) A piece of timber set underneath a prop. (Gresley)
4. The major fault plane over which other beds ride forward as a group during distributive faulting. (Leith, p. 49)

Solene. Synonymous with Gasoline and Petroleum ether, which *see.* (Bacon)

Solenhofen stone. A limestone found at Solenhofen, Bavaria, valued for lithographic purposes. (Webster)

Sole piece. *See* Sole, 3.

Sole plate (Scot.). The plate on which a machine rests. (Barrowman)

Solera (Sp.). 1. A stone or cast-iron bottom of a Chilian mill; a hearth stone; well or bottom of a furnace. 2. The lower mill stone. 3. A ground sill. 4. A railroad tie. 5. A rest for grate bars. 6. The shoe of a stamp. (Halse)

Soleta (Spain). A clay band occurring above a coal seam. (Halse)

Solevantamiento (Sp.). Elevation of strata; an uplift. (Lucas)

Solfanaria (It.). A sulphur mine. (Standard)

Solfatara. An expiring or dormant volcanic vent from which steam and vapors are emitted; also a district or area in which volcanic emanations are given off from fissures and small vents. *Compare* Fumarole, Mofette, and Soffioni. (La Forge)

Solicitud (Mex.). The application for a mining claim. Petition. (Dwight)

Solid. 1. Coal that has not been undermined, sheared, cut, or otherwise prepared for blasting. Used in the expression, "Shooting off the solid." 2. That part of the coal which can not be thrown out by a single shot, or the coal beyond the *loose end.* Used in expressions describing holes drilled for blasting as "3 feet into the solid," or "on the solid." (Steel)

Solid crib-timbering. Shaft-timbering with cribs laid solidly upon one another. (Raymond)

Solid-drawn. Drawn from hollow ingots, or otherwise, on mandrels of successively decreasing diameters; said of certain seamless metal tubes. (Standard)

Solid water (Scot.). Water sufficient to fill the pump barrel at each stroke. (Barrowman)

Solid workings (Scot.). In stoop and room workings, the first working or room driven into the solid coal (Barrowman). Distinguished from Pillar-work or Pillar-drawing.

Sollamadizo (Peru). Rock liable to run or cave. (Halse)

Sollame (Peru). A cave or run. *See* Derrumbe. (Halse)

Sollar; Soller. 1. The plank flooring of a gallery covering a gutter-way beneath. 2. The platform in a shaft between two ladders. (Ihlseng)
3. A longitudinal partition forming an air passage between itself and the roof in a working. (Webster)
4. (Mich.). A platform from which trammers shovel or throw the ore or rock into a car. (Lesh *v.* Tamarack Min. Co., 152 N. W. Rept., p. 1022)
See also Saller.

Soluble glass. A simple silicate of potash or soda, or both. (Ure)

Solute. The substance dissolved in a solution. (Rickard)

Solution. 1. The change of matter from the solid or gaseous into the liquid state by its combination with a liquid; when unaccompanied by chemical change, called *physical solution;* otherwise, *chemical solution.* 2. The result of such change; a liquid combination of a liquid and a nonliquid substance. (Standard)

Solution plane. A direction in a crystal of relatively easy solubility, as when the substance is under great pressure. Chemical action along solution planes in minerals in rocks has often resulted in Schillerization. (Webster)

Solution pressure. Pressure due to the tendency of atoms or molecules to pass into solution; specifically, that tending to drive metals into solution, which is the cause of the electric current from a primary battery. (Webster)

Solvay process. A soda-making process by which a concentrated solution of common salt is treated with ammonia and carbon dioxide, yielding sodium bicarbonate, the ammo-

nia being recovered by lime or magnesia; the ammonia-soda process. (Standard)

Sölvsbergite. An aphanitic or slightly porphyritic igneous rock, intermediate between grorudite and tinguaite, having the composition and texture of trachyte. (La Forge) In the most basic variety quartz entirely fails and nephelite appears. (Kemp)

Sombra (Sp.). Shade; gray tinge of certain ores or matrices of ores. (Min. Jour.)

Sombrero (Sp.). 1. A hat. 2. *S. de hierro*, gossan. *See* Colorados. 3. (Peru) A cap-piece used in timbering. 4. A cowl, bonnet, hood, or dome. (Halse)

Somero (Sp.). Superficial deposits. (Halse)

Sonda (Sp.). A boring tool. (Halse)

Sondear (Sp.). To sink a prospect bore-hole. (Dwight)

Sondeo (Sp.). A prospect bore-hole. (Dwight)

Sooty coal (Eng.). Dull, soft coal. (G. C. Greenwell)

Soplado (Colom.). Alluvium deposited by a cataract or a strong current of water. (Halse)

Soplador (Sp.). A blower of gas. (Halse)

Soplante (Sp.). A blowing engine. (Halse)

Soplar (Sp.). To furnish blast for a furnace. (Dwight)

Soplete (Sp.). Blowpipe; tuyère; *Ensaye al soplete*, a blowpipe assay. (Dwight)

Soplo (Sp.). Blast, as for a furnace. (Dwight)

Soquete (Mex.). 1. Clay for stopping furnace tap. 2. Clay in vein. (Dwight)

Soquetero (Mex.). One who wets and kneads clay to be used at the furnace. (Dwight)

Sordavalite. An old name for the glassy salbands of small diabase dikes formerly regarded as a mineral. It is derived from Sordavala, a locality in Finland. *Compare* Wichtisite. (Kemp)

Soret's principle. That principle by which, if differences of temperature are induced in a solution of common salt or other substance in water, the dissolved material will become relatively concentrated in those portions in which the temperature is lowest. (Ore Dep., p. 64)

Soroche. 1. (Peru) A disease caused by rarefaction of air at great altitudes. 2. *S. plomoso* (Mex.) Lead carbonate; *S. reluciente*, argentiferous galena. (Dwight)

Sorter. One who sorts or classifies ore by hand.

Sorting hammer. A hammer for breaking up ores in sorting. (Standard)

Sory. A black earth impregnated with vitriol; vitriols in general. (Webster)

Sos (So. Staff.). To sink into the floor under great pressure from overlying strata (Gresley). Said of mine timbers and pillars.

Sosa (Sp.). 1. Soda ash. 2. Native carbonate of soda. (Halse)

Soterramiento (Sp.). The caving-in of mine workings. (Halse)

Sotlanque (Mex.). Chalcopyrite.

Sotominero (Sp.). A deputy mine captain. (Lucas)

Souffle. Spotted or mottled by blowing liquid color upon it, as through lace or network; said of pottery decoration. (Standard)

Sough (Eng.). An adit for draining a mine; a ditch; a drain. (Webster)

Sounding. 1. Knocking on a roof to see whether it is sound or safe to work under. 2. Rapping on a pillar to signal a person on the other side of it, or to enable him to estimate its width. (Steel)

Sour. 1. Having an acid or tart taste. Applied to minerals having the taste of sulphuric acid. (Dana)
2. To macerate and render fit for plaster or mortar; said of lime. (Webster)

Sonténement (Fr.). The propping and packing to support the roof. (Gresley)

South Staffordshire or Thick-seam method. *See* Room-and-pillar method.

Sow. 1. A tool used in sharpening machine-drill bits. (Gillette, p. 54)
2. A channel or runner which conducts the molten metal to the rows of molds in the pig bed. 3. A mass of metal solidified in such a channel or mold. (Webster)

4. An accretion that frequently forms in the hearth or crucible of a furnace. It consists mainly of iron. Also called Salamander, Bear, or Shadrach. 5. (Western U. S.) A movable shed used as a protection by miners. (Standard)

Sowback. Same as hogback or horseback; a kame or drumlin.

Soyote (Mex.). Vug. (Dwight)

Spaad. A fibrous talc. From the German *spath.* (Webster)

Space of discission. *See* Discission.

Space of dissolution. *See* Dissolution.

Spacing. In quarrying, the distance between drill holes in a row. (Bowles)

Spad. *See* Spud.

Spade. A cameo-cutter's tool, used with diamond powder. (Webster)

Spadiard (Corn.). A worker in the tin mines. (Standard) Also Spalliard.

Spal (Corn.). *See* Spall.

Spale. 1. (Corn.) In mining, to fine for disobedience of orders. (Raymond)
2. A variation of Spall. 1.

Spall; Spawl. 1. To break ore. Ragging and cobbing are, respectively, coarser and finer breaking than spalling, but the terms are often used interchangeably. Pieces of ore thus broken are called spalls. (Raymond)
2. In masonry, to reduce irregular blocks of stone, approximately to size by chipping with the hammer. (Webster)

Spalliard; Spallier. (Eng.). A pickman; a working miner. A laborer in tin works. (Pryce)

Spalling-floor. A place for spalling. (Standard)

Spalt. A scaly whitish mineral, used as a flux for metals. (Standard)

Span-beam (Eng.). A long wooden beam supporting the head pivot of the drum axle of a gin, and resting at the extremities upon inclined legs. (Gresley)

Spangle gold (Aust.). Smooth, flat scales of gold. (Davies)

Spanish chalk. A variety of talc or soapstone from Aragon, Spain. (Century)

Spanish furnace. A form of reverberatory furnace used in the lead districts of Spain. (Century)

Spanish ocher. A variety of red ocher. (Standard)

Spanish tile. Roofing tile having an S-shaped cross section. (Ries)

Spanish topaz. *See* False topaz.

Spar. 1. As used, loosely, almost any transparent or translucent, readily cleavable, crystalline mineral having a vitreous luster (La Forge), as calcspar, fluorspar, feldspar, heavyspar, etc.
2. A Cornish name for quartz.

Sparable tin (Corn.). Tin ore in grains like sparables or small nails. (Webster)

Spare (No. of Eng.). A wedge from 6 to 8 inches long, for driving behind plates when adjusting them to the circle of the shaft (Gresley). Also called Spear wedge.

Sparkle metal. A copper matte containing about 74 per cent copper. (Webster)

Sparry. Resembling, consisting of, or abounding with spar; spathic. (Webster)

Sparry coal (Scot.). Coal, the backs or joints of which are filled with calcite. (Barrowman)

Sparry iron. Siderite. (Webster)

Sparry lode. A lode filled with spar, *e. g.*, fluorspar, calcspar, or heavyspar. (Power)

Spartaite. A variety of calcite containing some manganese. (Century)

Spathic. Of, pertaining to, or resembling spar, especially, having cleavage. (Standard)

Spathic iron ore. *See* Siderite.

Spathose. Same as Spathic.

Spatter cone. A secondary or "parasitic" lava cone. (Chamberlin, vol. 1, p. 580)

Spattle. 1. To sprinkle, as earthenware, with glaze or colored slip; to make pasty-colored ware. 2. A tool for mottling a molded article. (Standard)

Spattling-machine. A machine for spattling earthenware. (Standard)

Spatula. An implement shaped like a knife, flat, thin, and somewhat flexible. Used especially in chemical laboratories and assay offices.

Spavin; Spavan (York.). Clunch, or ordinary bottom or underclay. (Gresley)

Spawl. *See* Spall.

Speak (Aust.). To give signs of weight by cracking. Said of mine props. (Power)

Speaking flame-lamp (Eng.). An early type of safety lamp. *See* Singing lamp.

Spear (Eng.). A wooden pump rod cut into lengths of about 40 feet, and, for heavy work, often measuring 16 inches square. Wrought-iron spears are also used. (Gresley)

Spear plates (Eng.). Wrought-iron plates bolted to the sides of spears where joined together. (Gresley)

Spear pyrite. A variety of marcasite, in twin crystals resembling the head of a spear. (Webster)

Spear-wedge (Aust.). A long wooden wedge used for centering iron tubbing and which helps to pack up the space between the tubbing and the rock (Power). Also called Spare.

Special place (Aust.). A place where coal cannot be won so easily as in ordinary working places; *e. g.*, development work, headings, etc. (Power)

Special steel. Steel in which another element than carbon gives the characteristic hardness, as chrome or nickel steel. (Standard)

Specific gravity. The ratio of the weight of a body to that of an equal volume of some standard substance, water in the case of solids and liquids, air in the case of gases; numerically equal to the density. (Standard)

Specific heat. The number of units of heat required to raise a unit of mass of any substance one degree in temperature. (Standard)

Specimen. Properly speaking, a sample of anything; but among miners it is often restricted to selected or handsome minerals, as fine pieces of ore, crystals, or pieces of quartz containing visible gold. (Roy. Com.)

Speckstone. Adapted from Speckstein, "bacon-stone"; an early name for talc, because it feels greasy. (Chester)

Spectacle. A two-handled frame for carrying well-boring tools. (Standard)

Spectacle furnace. A form of shaft-furnace, used in Germany, with two tap holes, having an inclined bottom from which the melted metal flows into an outside receptacle. (Standard)

Spectacle stone. An early popular name for selenite, alluding to its transparency. (Chester)

Spectroscope. An instrument used to produce a spectrum of the light from any source by the passage of the rays through a prism or their reflection from a grating, and for the study of the spectrum so formed. (Century)

Spectrum. The continuous band of light showing the successive prismatic colors or the insolated lines or bands of color. (Century)

Specular. Mirror-like, as *specular* iron ore, which is a hard variety of hematite. *See* Specularite.

Specular coal. Same as Pitch coal.

Specular iron. *See* Specularite.

Specularite; Specular hematite; Specular iron; Gray hematite. An iron oxide, Fe_2O_3, occurring in tabular or disklike crystals of gray color and splendent metallic luster. Also called "micaceous hematite" if occurring in foliated or micaceous masses. Contains 70 per cent iron. *See* Hematite. (U. S. Geol. Surv.)

Specular schist. *See* Itabirite.

Specular slate-ore. A laminated ore with smooth face and brilliant reflection (Standard). *Compare* Itabirite.

Specular stone. Mica. (Standard)

Speculum metal. An alloy of copper, 66, and tin, 33 parts (Ure). Used in making the mirrors of reflecting telescopes.

Speed (Corn.). A quick, but wasteful way of dressing, or rather coarse cleaning of copper ore, by an iron grate in a swift current of water. (Pryce)

Speiss; Speise (Ger.). A basic arsenide, or antimonide of iron, often with nickel, cobalt, lead, bismuth, copper, etc., having a metallic luster, high specific gravity, and strong tendency toward crystallization. It takes up gold with avidity, but has a less affinity for silver than copper matte. The speiss obtained in lead-smelting is an arsenical speiss. Antimonial speiss is occasionally made in smelting skimmings. (Peters, p

231; Hofman, p. 354). Impure metallic arsenides (principally of iron), produced in copper and lead smelting. Cobalt and nickel are found concentrated in the speiss obtained from ores containing these metals. (Raymond)

Spell. A rest period for crews at furnace, stock house, etc., or a period of work in drilling the tap hole (Willcox). A change or turn.

Spellerizing. Subjecting the heated bloom to the action of rolls having regularly shaped projections on their working surface, then subjecting the bloom while still hot to the action of smooth-faced rolls. The surface working is said to give a dense texture to pipe made from the bloom, adapting it to resist corrosion. (Liddell)

Spelter. The zinc of commerce, more or less impure, in slabs, plates or ingots cast from molten metal. It does not include zinc dust.

Spelter solder. Hard solder containing zinc. (Standard)

Spence automatic desulphurizer. An improved Malétra furnace provided with automatic rakes. (Peters, p. 220)

Spence furnace. A furnace of the muffle or reverberatory type, the ore being supported on shelves and stirred mechanically. (Ingalls, p. 156; Peters, p. 214)

Spend. 1. To break ground; to continue working. (Raymond)
2. To exhaust by mining; dig out; used in the phrase *to spend ground.* (Standard)

Spent shot. A blast hole that has been fired, but has not done its work. (C. and M. M. P.)

Sperrylite. Platinum arsenide, $PtAs_2$. The theoretically pure mineral would contain 56.5 per cent platinum, but antimony and rhodium are also present in small quantities. (U. S. Geol. Surv.)

Spessartite. 1. A variety of garnet. *See* Garnet. (U. S. Geol. Surv.)
2. A dike rock which, whether porphyritic or granitoid in texture, consists of prevailing plagioclase, hornblende, and diopside. Orthoclase and olivine occasionally appear. The name is derived from Spessart, a group of mountains in the extreme northwest of Bavaria, but as it has already been used for a variety of garnet, it is a very unfortunate selection. (Kemp)

Spew. The cauliflower-like blowout or outcrop of a lode that extends beyond the limits of the defined vein deeper down. (Power)

Spewing. An exudation of soft material through gravelly or broken stuff bedded on mud, soft wet clay, or the like. (Webster)

Sphærite. A hydrous phosphate of aluminum, allied to Wavellite. (Century)

Sphalerite; Blende; Blackjack; Jack; Rosinjack; Zinc blende. A sulphide of zinc, ZnS, crystallizing in isometric forms. Contains 67 per cent zinc. *See* Wurtzite (U. S. Geol. Surv.). Called also Mock-lead; False galena.

Sphene. Calcium silicotitanite, $CaTiSiO_5$ (Dana). Called also Titanite.

Sphenoid. In crystallography, a hemihedral form (1) of the orthorhombic system included under four equal scalene triangular faces, or (2) of the tetragonal system included under four equal isosceles triangular faces. (Standard)

Sphenolith. A term invented to distinguish the special form and relations of intrusion at Las Parroquias, Mexico. A rock mass of the injected class, partly concordant like a thick sill, and partly discordant. The country rocks have been displaced and even overturned. (Daly, p. 88)

Sphere ore. Fragments of rock encrusted with metallic minerals. Cocarde ore. (Power)

Spherocobaltite. Cobalt carbonate in spherical masses and having a peach-blossom red color. (Century)

Sphero-crystal. A homogeneous spherulite formed of minute crystals branching outward from the center (Standard). *See* Spherulite.

Spheroidal. 1. A descriptive term applied to igneous rocks that break up on cooling into spheroidal masses analogous to basaltic columns; also used as a synonym of orbicular as applied to certain granites. (Kemp)
2. In crystallography, enclosed by convex surfaces. (Standard)

Spherosiderite. A variety of iron carbonate occurring in globular concretionary forms. (Century)

Spherulite. A rounded or spheroidal aggregate, not uncommonly concentrically zoned, more rarely hollow, of radiating, prismatic or lath-like crys-

tals of one or more minerals, formed in some igneous rocks under certain conditions of crystallization. (La Forge)

Spherulitic ore. A globule of ore having a radiated structure. Sphere ore. (Power)

Spider. A skeleton or frame having radiating arms or members, as a casting forming the hub and spokes to which the rim of a wheel is secured (Webster). *See* Drum horns.

Spider-web rock (Ohio). A local term for sandstone beds that show cross bedding on a small scale, which is complicated by intricate interlacing of fine bedding planes (Bowles). Frequently seen in sawed stones, especially where the lamination is slightly oblique or irregular. It is very like the grain of wood that shows in a planed board. (Merrill)

Spiegeleisen. Manganiferous white cast iron (Raymond). Used in the manufacture of steel by the Bessemer process. Called Spiegel; Spiegel-iron.

Spigot. 1. The end of a pipe, fitting or valve that is inserted into the bell end. 2. The tapered male part of an inserted joint, as in plumber's wiped joint. 3. A cock, tap, or faucet used to draw water, etc. (Nat. Tube Co.)

Spigot joint. A pipe joint made by tapering down the end of one piece and inserting it into a correspondingly widened opening in the end of another piece. Sometimes called Faucet joint. (Nat. Tube Co.)

Spike amygdule. A cylindrical amygdule whose longer axis is at right angles to the bedding. (Standard)

Spike team. 1. A team consisting of three draft animals, two of which are at the pole while the third leads (Century). Three mules, two abreast and one in the lead, used in a mine to haul coal cars. (Himrod Coal Co. *v.* Clingan, 114, Illinois App., p. 570)
2. (Ark.) A tandem team of mules for hauling coal. (Steel)

Spiking curb (Eng.). A curb to the inside of which plank tubing is spiked. (Raymond)

Spilching (Eng.). A soft, friable machine-made brick. (Standard)

Spile. 1. A temporary lagging driven ahead on levels in loose ground. See Spill. 2. A short piece of plank sharpened flatways and used for driving into watery strata as sheet piling to assist in checking the flow. (Steel)
3. A large timber for forcing into the ground to serve as a foundation; a pile. (Standard)

Spilite. An early French name for dense, amygdaloidal varieties of diabase. (Kemp)

Spill. Any of the thick laths or poles driven ahead of the main timbering to support the roof or sides in advancing a level in loose ground, or to support the sides of a shaft when sinking through a stratum of loose ground (Webster). Same as Spile, 1 and 2.

Spilling (Corn.). A process of driving or sinking through very loose ground (Raymond). Also the flat timbers used in the process. *See* Spile; *also* Spill.

Spill-trough. A trough to receive melted brass that may be spilled in pouring from a crucible into a flask. (Standard)

Spillway. 1. A passage for superfluous water in a reservoir, to prevent too great pressure on the dam. 2. A paved apron or a dam over which the water flows. (Webster)

Spilosite. A contact metamorphic rock composed chiefly of chloritic and feldspathic material and formed from shale or argillite by the heat of diabasic intrusions (La Forge). It corresponds to the hornfels of granite contacts. (Kemp)

Spindle. 1. In founding, a rod or pipe used in forming a core. (Standard)
2. (Derb.) A small piece of wood set in the ground to mark the boundary of a mine. (Mander)

Spindle breaker. A gyratory rock breaker or crusher. (Richards, p. 1206)

Spindle oil. The lighter portion of the petroleum distillates suitable for lubrication of light-running machinery. (Bacon)

Spine. A mass of igneous rock solidified in the vent of a volcano; a plug. (Daily, p. 130)

Spinel. An isometric mineral, typically magnesium alluminate, $MgO.Al_2O_3$. The magnesium may be in part replaced by ferrous iron, or manganese, and the aluminum by ferric iron and chromium. Spinel is red, yellow, green, black, and other colors, and is used as a gem. (U. S. Geol. Surv.)

Spiracle. One of the minute cones formed on the surface of a liquid lava stream by steam or gases escaping from the mass. Called also Bocca. (Standard)

Spiral. A spiral coal chute that mechanically separates the slate from the coal. The coal being irregular in shape and light falls over the edge of the spiral due to centrifugal force, while the flatter and heavier slate adheres somewhat to the chute surface and is carried down to a special pocket.

Spiral drum. A kind of conical winding drum. (Gresley)

Spiral worm (Eng.). A tool for extricating broken boring rods. (Gresley)

Spire. 1. The tube carrying the train to the charge in a blast hole. Also called Reed or Rush, because these, as well as spires of grass, are used for the purpose. (Raymond) A kind of fuse.
2. (Leic.) Coal of a hard, dull, slaty, nature, and difficult to break. (Gresley)

Spirit of alum. An aqueous solution of sulphur dioxide. (Webster)

Spirit of copper. Acetic acid obtained by distilling copper acetate.

Spirit of salt. Hydrochloric acid; formerly so called. (Standard)

Spirit of tin. Stannic chloride. (Webster)

Spirit of vitriol. Sulphuric acid; oil of vitriol. (Webster)

Spit. 1. A small point of land extending into a body of water, or a long, narrow shoal extending from the shore. (Webster)
2. To light a fuse. (Duryee)
3. (Prov. Eng.) A spade's depth in digging. 4. (Virginia, U. S.) In brickmaking, a certain amount of brick clay. (Standard)

Spitting. 1. An action of or appearance on the surface of slowly cooled large masses of melted silver or platinum, in which the crust is forcibly perforated by jets of oxygen, often carrying with them drops of molten metal. Called also Sprouting. (Standard)
2. Lighting the fuse for a blast. (Du Pont)

Spitzkasten. A series of hopper-shaped or pointed boxes for separating mineral-bearing slimes, according to fineness, in which the width of each box is double that of its predecessor, while the lengths increase by arithmetical progression (Richards). *See* Funnel box.

Spitzlutte. A device, for classifying ore slimes, consisting of a V-shaped box, as distinguished from the pyramidal boxes of the spitzkasten. Classification is dependent on the downward movement of ore particles in a rising stream of water admitted at the bottom. (Liddell)

Splasher. A plate lined with fire brick and placed over the iron trough next to the tap hole to keep down flame that blows from the tap hole during a cast. (Willcox)

Splendent. Applied to the degree of luster of a mineral, reflecting with brilliancy and giving well-defined images, as hematite, cassiterite. (Dana)

Splent (Aust.). *See* Splint.

Spliced. Applied to veins when they pinch out and are overlapped at that point by another parallel one. (Power)

Splint; Splint coal. A hard variety of bituminous coal that ignites with difficulty, owing to its slaty structure, but makes a clear, hot fire. Called also Splent; Splent-coal. (Standard)

Split. 1. To divide an air current into two or more separate currents. 2. Any division or branch of the ventilating current. 3. The workings ventilated by that branch. 4. Any member of a coal bed split by thick partings into two or more seams. 5. A bench separated by a considerable interval from the other benches of a coal bed. (Steel)
6. To divide a pillar or post by driving through it one or more roads. (Gresley)

Split brilliant. A brilliant split apart at the base of its pyramidal forms, so as to make two gems. (Standard)

Split rock. A rock possessing tabular structure, or which cleaves easily in the lines of lamination, and consequently suitable for flagging and curbstones. (Merrill)

Split shovel. A device for sampling ore, consisting of a fork in which the prongs are separate scoops, each scoop being the same width as the open spaces between. (Richards, p. 844)

Split the air (Scot.). Same as Split, 1.

Splitter. One employed in the mica industry whose duty it is to separate mica into thin sheets.

Splitting knife. A knife used for diamond cleaving. (Standard)

Splittings (Lanc.). Two horizontal level headings driven through a pillar, in pillar workings, in order to mine the pillar coal. (Gresley)

Splitting shot (Ark.). A shot put into a large mass of coal detached by a previous blast (Steel). *See* Block hole.

Spodumene. Lithium-aluminum silicate, $Li_2O.Al_2O_3.4SiO_2$. Used as a source of lithia, of which it contains as a maximum 8.4 per cent. The clear green variety, hiddenite, and the clear pink or lilac, kunzite, are used as gems. (U. S. Geol. Surv.)

Spoil. 1. Débris or waste material from a coal mine. (C. and M. M. P.) 2. (Eng.) A stratum of coal and dirt mixed. (Gresley)

Spoil bank; Spoil heap (Eng.). The place on the surface where spoil is deposited. (Gresley)

Sponge. Metal in a porous form, usually obtained by reduction without fusion. *See* Chenot process. (Raymond) A porous, sponge-like form assumed by finely divided metals, as iron and platinum, in which condition they are serviceable as oxidizing agents. (Standard)

Spongy iron. *See* Reduced iron. *also* Sponge.

Spontaneous combustion. Combustion produced in a substance by the evolution of heat through the chemical action of its own constituents. (Webster)

Spoon. 1. An instrument made of an ox or buffalo horn, in which earth or pulp may be delicately tested by washing to detect gold, amalgam, etc. 2. *See* Spoon end. (Raymond) 3. A slender iron rod with a cup-shaped projection at right angles to the rod, used for scraping drillings out of a bore hole. (Steel)

Spoon end. The edge of a coal basin when the coal seam spoons, *i. e.*, rises to the surface after growing thinner as it approaches its termination. Also called Spoon. (Power)

Spore coal. Coal formed out of the spores of lycopods. (Power)

Spotted. An irregularity of the ore content of any vein; pockety.

Spout. 1. (So. Staff.) A short underground passage connecting a main road with an air heading. (Gresley)
2. (Newc.) A box or trough down which coal is run from the wagons or cars into ships. (Min. Jour.)

Spouter. An oil well the flow of which has not been controlled by the engineers. (Webster)

Spout hole (So. Wales). A short siding upon which trams are loaded in the mine. (Gresley)

Spout mouth (Scot.). A place on a level road where the material from a spout (or chute) is filled into the cars. (Barrowman)

Spout road (Scot.). A chute so steep that the mineral slides down to the haulage level. (Barrowman)

Sprag. 1. A short wooden prop set in a slanting position for keeping up the coal during the operation of holing. 2. A short round piece of hardwood, pointed at both ends, to act as a brake when placed between the spokes of a mine-car wheel. 3. (Arkansas). Heavy slanting props wedged against the coal to prevent it from flying when blasted. (Steel)

Spragger. One who travels with the trip of cars to attend to sprags and switches (Hargis). *See* Sprag, 2.

Sprag road. A mine road having such a sharp grade that sprags are needed to control the descent of the car,—hence, Two, Three, or Four-Sprag-road. (Chance). *See* Sprag, 2.

Spreader. 1. A horizontal timber below the cap of a set, to stiffen the legs, and to support the brattice when there are two air courses in the same gangway. 2. A piece of timber stretched across a shaft as a temporary support of the walls. (Raymond)
3. A tool used in sharpening machine-drill bits. (Gillette, p. 53)
4. A bar used as a distance piece, as any of a series of cross bearers to support a line of rails in an adit. (Webster)

Spring. 1. A general name for any discharge of deep-seated hot or cold, pure or mineralized water. (Power) 2. To enlarge the bottom of a drill hole by small charges of a high explosives in order to make room for the full charge; to chamber a drill hole.

Spring beams (Eng.). Two stout parallel timbers built into a Cornish pumping-engine house, nearly on a level with the engine beam, for catching the beam, etc., and preventing a smash in case of accident. (Gresley)

Spring dart (Eng.). An arrow or fish-headed boring tool for extricating a lost implement, or for withdrawing lining tubes. (Gresley)

Spring dog (Scot.). Same as Spring hook.

Spring hook (Eng.). An iron hook attached to the end of a winding, capstan, or crab rope, fitted with a spring for closing the opening, and thus preventing the kibble or tub from falling off. (Gresley)

Springing. *See* Spring, 2. Also called Bullying; Chambering; Shaking a hole.

Springing line. The line from which an arch springs or rises. (Century)

Spring latch. The latch or tongue of an automatic switch, operated by a spring at the side of the mine track. (Steel)

Spring pole. An elastic wooden pole from which boring rods are suspended (Steel). Also sometimes employed for shallow pumping, when it is actuated by cams or cranks from an engine. (Gresley)

Spring steel. A variety of rolled steel, elastic, strong, and tough, used for springs, etc. (Webster)

Sprocket wheel (Eng.). Rag wheel. A wheel with teeth or pins which catch in the links of a chain. (C. and M. M. P.)

Spruce ocher. Brown or yellow ocher. (Century)

Sprue. 1. A piece of metal attached to a casting, occupying the gate or passage through which the metal was poured. (Raymond)
2. A molder's rod for making sprue holes. (Standard)

Sprue hole. A pouring hole in a mold; a gate. (Standard)

Spud. 1. A nail, resembling a horseshoe nail, with a hole in the head, driven into mine timbering, or into a wooden plug inserted in the rock, to mark a surveying station (Raymond). *Also* Spad.
2. To work the boring tool by means of the bull wheel alone in starting an oil well. 3. A potato. (Webster)
4. A long steel or wooden pole used for anchoring a dredge. (Weatherbe)
5. A tool having a long curved blade used to work around and recover tools from a bored well. (Standard)

Spudding bit. A broad dull drilling tool for working in earth down to the rock. (Standard)

Spud setter. A mine surveyor. Compare Spud, 1.

Spunney (Lanc.). A selfacting plane or incline. (Gresley)

Spur. 1. (Scot.) A portion of the coal left unholed to support the coal seam till the rest of the holing is completed. Frequently called Spurring; also Spurn. (Barrowman)
2. A ridge or small elevation that extends from a mountain, or range of mountains, projecting to some distance in a lateral direction, or at right angles. 3. (Eng.) To prop or brace. (Webster)
4. A branch leaving a vein, but not returning to it. (Raymond)
5. A prism or tripod of refractory clay, to support an article while being baked; a stilt. (Standard)

Spurns (So. Staff.). Small connecting masses of coal, left for safety during the operation of cutting, between the hanging coal and the main body. *See* Spur, 1. (Raymond)

Spur road (Scot.). A branch road leading from a main level. (Gresley)

Spurt (Forest of Dean). A disintegrated stone. (Gresley)

Spur track. In railroading, a short branch line of track; a stub track. (Webster)

Squad. 1. (Prov. Eng.) Mire; slime; mud. 2. A small bunch of loose tin ore mixed with earth. Also called Squat. (Standard)

Squander (York.). To extinguish an underground fire. (Gresley)

Squareman (Eng.). A stone-cutter or stone-dresser. (Standard)

Square-set. A set of timbers composed of a cap, girt and post. These members meet so as to form a solid 90°-angle. They are so framed at the intersection as to form a compression joint, and join with three other similar sets. The posts are 6 or 7 feet high while the caps and girts are 4 to 6 feet long.

Square-set and fill. *See* Square-set stoping.

Square-set slicing. *See* Top slicing and cover caving.

Square-set stoping. The use of square-set timbering as an essential feature of overhand stoping. The stope may be worked in horizontal slices, as a stepped face, or in vertical slices. The modifications are Open stope, Partly filled stope, Filled stope, Vertical slice (underhand), Vertical slice (overhand), Alternate pillar and stope, cover the more important variations (Young). Also known as Nevada system, Square-set underhand, Pillar and stope, Back filling method, and Square-set and fill.

Square-set system. A method of mine timbering in which heavy timbers are framed together in rectangular sets, 6 or 7 feet high, and 4 to 6 feet square, so as to fill in as the ore body is removed by overhand stoping. (Webster)

Square-set underhand. *See* Square-set stoping.

Square timbering (Eng.). The formation of a shaft through an excavation. It consists of square settings or frames at intervals, close-poled behind. (Simms)

Square work. 1. (So. Staff.) An old system of working the thick coal by mining the upper beds first and then the lower ones. 2. A system of working a seam of coal by cutting it up into square blocks or pillars. *See* Stoop-and-room. (Gresley)

Square work and caving. *See* Sublevel stoping.

Squat. 1. (Corn.) Tin ore mixed with spar (Raymond). Also called Squad
2. A small ore body in a vein. (Standard)

Squat lads! Fall flat down on the floor! In the early days of coal mining, igniting the gas was a very common thing; so, whenever an explosion took place, the colliers shouted to one another, "Squat, lads!" *See* She's fired! (Gresley)

Squat of ore (Eng.). A bunch of ore. (Min. Jour.) *See* Squat.

Squealer. A shot that breaks the coal only enough to allow the gases of detonation to escape with a whistling sound; also called a whistler. (C. and M. M. P.)

Squeal-out (Ark.). *See* Seam-out; Squealer.

Squealy coal (Ark.). Seamy coal from which the powder gases escape with a squealing sound. (Steel)

Squeeze. 1. The settling, without breaking, of the roof over a considerable area of working (Raymond). Also called Creep, Crush, Pinch, and Nip.
2. The gradual upheaval of the floor of a mine, due to the weight of the overlying strata. (Woodson)

Squeezer. A machine for reducing the puddle-ball to a compact mass, ready for the hammer or rolls. (Raymond). Also called Alligator.

Squeezing-box. A metal cylinder having at its bottom an orifice through which a mass of plastic clay is forced in the shape of a long roll, from which handles may be cut, as for jugs. (Standard)

Squib. 1. A tapered paper tube, about 7 inches long, filled with fine gunpowder, one end of the tube being treated with chemicals so as to form a slow burning match, which, when ignited, burns so slowly as to give the miner time to reach a place of safety before the explosion. When used, the squib is placed in the needle hole, or blasting barrel, through the tamping, with the match end of the squib outward. (U. S. Bu. Mines, Bull. 17, p. 33)
2. Small charge of powder exploded in the bottom of a drill hole, to spring the rock, after which a heavy shot is fired (Steel). A springing shot.
3. In well boring, a vessel, containing the explosive and fitted with a time fuse, that is lowered into a well to detonate the nitroglycerin charge. (Nat. Tube Co.)

Squib shot. A blast with a small quantity of high explosives fired at some point in the bore hole for the purpose of dislodging some foreign material which has fallen into it. (Du Pont)

Squirting. Forcing lead by hydraulic pressure into the form of rods or pipes. (Raymond)

Stable-boss. A man placed in charge of the stables and of the animals employed at a mine.

Stack. 1. A chimney. 2. A shaft furnace. (Raymond)
3. To build up coal, ironstone, etc., into heaps on the surface for winter or other use. (Gresley)

4. In gas works, a row of benches containing retorts. 5. One of the piles or layers of dung or tan, pots containing acid, and sheets or wickets of lead, in the old processes for making white lead. (Webster)
6. (Eng.) A measure of fuel consisting of 108 cubic feet. (Standard)

Stacker. 1. One who stacks coal, etc. 2. (Leic.) A miner who looked after the unloading of the coal on the bank, on behalf of the miners, in the earlier days of mining. (Gresley)
3. A device fixed at the rear of a dredge and carrying a conveyer belt to stack the waste material behind the boat so that it will not interfere with navigation. (Weatherbe, p. 71)

Stack out (Mid.). To dam off or shut up the entrance to a goaf by building a wall of stone, coal, and clay in front of it. (Gresley)

Staddle (Mid.). The foundation of a pack in ironstone workings. (Gresley)

Stadia. In surveying: 1. A temporary station. 2. A stadia rod. (Webster)
3. An instrument for measuring distances, consisting of a telescope with special horizontal parallel lines or wires, used in connection with a vertical graduated rod; also, the rod alone, or the method of using it. (Standard)

Stadia rod. A graduated rod used with an instrument of the stadia class to measure the distance from the observation point to the place where the rod is positioned. (Webster)

Stadia tables. Mathematical tables from which may be found, without computation, the horizontal and vertical components of a reading made with a transit and stadia rod.

Staff. 1. A body of assistants serving to carry into effect the plans of a superintendent or manager. (Webster)
2. A surveyor's leveling rod. 3. An iron puddler's rabble or rabbler. (Standard)

Staff hole. A small hole in a puddling furnace through which the puddler heats his staff. *See* Staff, 3. (Century)

Stage (Eng.). 1. The pit bank. 2. A certain length of underground roadway worked by one horse. (Gresley)
3. (Scot.) A narrow whin dike, especially one where the material of which the dike is composed is soft. (Barrowman)
4. In the nomenclature adopted by the International Geological Congress, the stratigraphic subdivision of the fourth rank; a division of a *series*. The chronologic term of equivalent rank is *age*. (These terms have not been adopted by the U. S. Geological Survey and they have no exact equivalents in the nomenclature used by that Survey.) (La Forge)
5. A platform on which mine cars stand. (C. and M. M. P.)

Stage crushing. A method of ore or stone crushing in which there is a series of crushers, each one crushing finer than the one preceding.

Stage pumping. Draining a mine by means of two or more pumps placed at different levels, each of which raises the water to the next pump above or to the surface.

Stage working. A system of working minerals by removing the strata above the beds, after which the various beds are removed in steps or stages. (C. and M. M. P.)

Staging. A temporary flooring or scaffold, or platform. (C. and M. M. P.)

Stahlstein (Steelstone). The German name for some pure crystalline carbonate of iron, because a kind of steel is readily made from such ores without passing through the process of cementation. (Page)

Stainless steel. *See* Chromium steel.

Stair pit (Scot.). A shallow shaft or staple in a mine fitted with a ladder or steps. (Gresley)

Staithe (No. of Eng.). A depot in which coal is placed when it comes from collieries by wagons, to be ready to be loaded into keels (boats). (Gresley)

Staithman (Eng.). A man employed at a staithe in weighing and shipping coal. (Standard)

Stake. 1. (Leic.). To fasten back or prop open with a piece of chain or otherwise the valves or clacks of a water barrel, in order that the water may run back into the sump when necessary. (Gresley)
2. Short for grubstake. 3. A property or interest involved. (Webster)
4. A pointed piece of wood driven into the ground to mark a boundary, survey station, elevation, etc.

Stalactite. Depending, columnar deposits, generally of calcite, formed on the roof of a cavern by the drip of mineral solutions. *Compare* Stalagmite. (Kemp)

Stalactitic marble; Stalagmitic marble. Marble obtained from the calcareous deposits on the roofs and floors of caves. Such are often beautifully banded and are known commercially as onyx marbles. (Merrill)

Stalagmite. Uprising, columnar deposits, generally of calcite, formed on the floor of a cavern by the drip of mineral solutions from the roof. *Compare* Stalactite.

Stalch (Eng.). A mass of ore left in a mine. (Hunt)

Stall. 1. (So. Staff.). A working place in a mine, varying in length from a few feet to 80 yards or more, according to the thickness of the seam and system of working adopted (Gresley). A room.
2. A small compartment in a furnace or kiln where ore is roasted. *See* Stall roasting.

Stall-and-breast. *See* Room-and-pillar method.

Stall-and-room work (Eng.). Working the coal in compartments, or in isolated chambers, leaving pillars to support the roof. (Gresley)

Stall gate; Stall road (Eng.). A road along which the mineral worked in a stall is conveyed to the main road. (Gresley)

Stalling (Eng.). Working in a stall, in the capacity of a butty or contractor. (Gresley)

Stall roasting. The roasting of ore in small enclosures of earth or masonry walls. The enclosures are called stalls and may be open or closed. (Peters, p. 140; Hofman, p. 361)

Stamp. 1. To break up the ore and gangue by machinery, for washing out the heavier metallic particles. (Whitney)
2. A heavy pestle raised by steam or other power for crushing ore. Those stamps in which the blow of the pestle is caused by its mere weight are called *gravity* stamps. *See* Stamp head. *See* Steam stamp.
3. (Eng.) A section of a bloom nicked or partially cut through, or broken off to show the grain. (Webster)
4. (Scot.). A hole or mark in the roof of a mine working from which measurements may be taken. (Barrowman)
5. (Eng.) A hole made in coal, with the pick, in which the wedge is fixed before driving. (G. C. Greenwell)
6. In brickmaking, to remove from an undried brick the rough edge caused by a mold-vent. (Standard)

Stamp battery. A heavy iron pestle working mechanically in a huge iron mortar. Generally grouped in units of five per mortar. Stamps vary up to 2,000 pounds in weight, dropping 6 to 8 inches and 100 or more times per minute. (Liddell)

Stamp copper. Copper produced from copper-bearing rock by stamping and washing before smelting.

Stamp duty. The amount of ore (tons) that one stamp will crush in 24 hours.

Stampede. Any sudden or impulsive movement on the part of a crowd or large company (Standard), as a *stampede* to a new gold field.

Stampeder. One who rushes into a new district when a discovery of gold or other precious metal is reported. *See* Rusher.

Stamper. A mill for powdering calcined flints for use in making porcelain. (Standard)

Stamper box. A stamp-mill mortar box. (Roy. Com.)

Stamp hammer. A power hammer that rises and falls vertically, like an ore stamp. (Webster)

Stamp head. A heavy and nearly cylindrical cast-iron head fixed on the lower end of the stamp rod, shank or lifter to give weight in stamping the ore. The lower surface of the stamp head is generally protected by a cheese-shaped "shoe" of harder iron or steel which may be removed when worn out. These shoes work upon "dies" of the same form laid in the bottom of the mortar or stamper box (Roy. Com.). *See* Stamp, 2.

Stamping. Reducing to the desired fineness in a stamp mill. The grain is usually not so fine as that produced by grinding in pans. (Raymond)

Stamping maundril (Leic.). A heavy pick. (Gresley)

Stamp mill. An apparatus (also the building containing the apparatus) in which rock is crushed by descending pestles (stamps), operated by water or steam-power. Amalgamation is usually combined with the

crushing when gold or silver is the metal sought, but copper and tin-ores, etc., are stamped to prepare them for dressing. (Raymond)

Stamp rock (Mich.). Rock containing fine copper that must be crushed and jigged to recover the metal. (Weed)

Stamps (So. Wales). The pieces into which the rough bars shingled from the finery ball are broken, to be piled for subsequent rolling into sheet-iron. (Raymond)

Stamps captain (Corn.). The superintendent or foreman of a stamp mill. (Pryce)

Stamp shoe. The heavy chilled iron casting attached to the lower end of a stamp piston, that does the actual crushing of rock in a stamp mill. It drops on a round steel block called a die. (Weed)

Stampsman. One who attends or operates a stamp or stamp battery.

Stamp-work (Lake Sup.). Rock containing disseminated native copper (Raymond). Stamp rock.

Stanch air (Som.). Choke damp. (Gresley)

Stanchion. A vertical prop or strut. (C. and M. M. P.)

Stand. In well drilling, three lengths of pipe ready for lowering into a well.

Standage (Eng.). A large sump, or more than one, acting as a reservoir. (Raymond)

Standard. 1. That which is set up and established by authority as a rule for the measure of quantity, weight, extent, value, etc. 2. The legal weight and fineness of metal used in coins. (Webster)
3. (Eng.) The fixed rate by which colliers' wages are from time to time regulated. *See* Sliding scale, 1. (Gresley)

Standard-air course (No. of Eng.). The quantity or supply of fresh air allowed to pass through each district or split. (Gresley)

Standard copper. Practically any brand of 96 per cent, or higher, fineness. (Skinner)

Standard gold (Eng.). Twenty-two parts of pure gold alloyed with two parts of copper or other metal. (Skinner)

Standard height (Aust.). A given height of seam, say 5 feet, below which the miner is paid so much extra for every inch short of the standard height. (Power)

Standard selling price (Aust.). An assumed price, not necessarily the actual selling price, adopted so as to afford a basis for a uniform mining rate. (Power)

Standard-white oil. A Russian kerosene which has a specific gravity of 0.808 to 0.812 and is standard white in color. (Bacon)

Stander (Eng.). A coal pillar left to support the roof. (Webster)

Standing. 1. A term used by well drillers to denote that work has been stopped for a considerable time. *See* Shut down. (Redwood, p. 245). Also applicable to mines and other industrial plants.
2. An iron floor covering the sunken part of a rolling mill. (Standard)

Standing bobby (No. of Eng.). An exploded shot that does not blow the stemming out, but expends itself in crevices or cleavage planes, without doing its work. (Gresley)

Standing fire. A fire in a mine continuing to smoulder for a long time; often many years. (Gresley)

Standing gas. A body of fire damp known to exist in a mine, but not in circulation; sometimes fenced off. (Steel)

Standing ground (Eng.). Ground that will stand firm without timbering. (Pryce)

Standing set (Eng.). A fixed lift of pumps in a sinking shaft. (Gresley)

Standing shot. The result of a small or undercharged shot wherein the coal is slightly loosened so that it is easily mined by pick (Hougland v. Avery Coal Mining Co., 246 Illinois, p. 616). The term is a misnomer, as it applies to the result and not the "shot" or "charge."

Standpipe. A high vertical pipe or reservoir for water used to secure uniform pressure in a supply system. (Webster)

Stane (Scot.). An obsolete form for stone. (Century)

Stanekite. A resinlike hydrocarbon derivative ($C_{20}H_{32}O_3$) found chiefly in coal deposits in Bohemia. (Standard)

Stank. (Mid.) A water-tight stopping; generally a brick wall. (Gresley)

Stanley header. *See* Header, 4.

Stannary. 1. A tin mine or tin works. (Raymond)
2. A region containing tin works. (Webster)

Stannary courts (Eng.). Courts in Cornwall and Devonshire for the purpose of regulating the affairs of tin mines and tin miners. (Century)

Stannary laws (Corn.). Regulations for the management, etc., of tin miners, administered by equity judges resident in Cornwall and Devon. (Min. Jour.)

Stannatores. An early name applied to Cornish tin miners. (Century)

Stanner. A small stone in or by a stream; a ridge of stones on the seashore; gravel. (Webster)

Stannic. Of, pertaining to, or containing tin; specifically designating compounds in which tin has a valence of four, as contrasted with *stannous*. (Webster)

Stanniferous. Yielding or containing tin, as *stanniferous* ores. (Standard)

Stanniferous ware. Pottery with a tin glaze. (Standard)

Stannite. A sulpho-stannate of copper, iron, and sometimes zinc. $Cu_2S.FeS.SnS_2$; 29.5 per cent copper, 27.5 per cent tin (Dana). Also called Tin pyrites.

Stannous. Pertaining to or containing tin; specifically, designating compounds in which tin has a valence of two, as contrasted with *stannic*. (Webster)

Stannum. Tin.

Staple. 1. (Eng.) A shaft, smaller and shorter than the principal one, joining different levels. 2. A small pit. (Webster). Used in coal mining. The American equivalent in metal mines is *winze*.
3. In founding, a piece of nail-iron pointed at one end and having a disk of sheet iron riveted to the other, used to steady a core and gage the thickness of the metal. (Standard)

Stapping (Scot.). A method of wedging down coal across the working face. (Barrowman)

Star antimony. Metallic antimony, the purity of which is evidenced on its surface by crystalline patterns resembling stars or fern leaves. (Webster)

Starling. 1. A structure of piles driven round the piers of a bridge for protection and support. Also Sterling (Webster). A sort of cofferdam.
2. One of the piles of such an inclosure. (Standard)

Star metal. Synonymous with Star antimony.

Star quartz. *See* Asteriated quartz.

Star reamer. A star-shaped tool for regulating the diameter of, or straightening a bore hole. (Gresley)

Star ruby. An asteriated variety of ruby. (Webster)

Star sapphire. An asteriated sapphire. (Standard)

Star stone. 1. A variety of ruby that exhibits a bright opalescent star of six rays in the direction of the principal axis. (Power)
2. An asteriated sapphire. 3. A cross-section of a petrified tree-fern when cut and polished. (Standard)

Start (No. of Eng.). A lever for working a gin to which the horse is attached. (Gresley)

Starter. 1. A drill used for making the upper part of a hole, the remainder of the hole being made with a drill of smaller gage known as a *follower*. (Bowles)
2. (Penn.) The miner who ascends to the battery to start the coal to run. (Chance)

Stassfurtite. A massive variety of boracite found in Prussia. It resembles a fine-grained white marble. (Century)

Static metamorphism. In geology, metamorphism produced by the internal heat of the earth and the weight of the superincumbent rocks and not accompanied by appreciable deformation. (La Forge) A term used in contradistinction to dynamic metamorphism which involves stresses principally due to thrust. (Sloan)

Statics. That branch of mechanics which treats of the equilibrium of forces, or relates to bodies as held at rest by the forces acting on them. (Webster)

Static zone. A term suggested for the zone which extends below the level of the lowest point of discharge, and in which the water is stagnant or moves with infinitesimal velocity. (Lindgren, p. 31.)

Station. 1. An enlargement of a shaft or gallery on any level, thus affording room for landing at any desired place, and at the same time provides space for receiving loaded mine cars that are to be sent to the surface. Empty cars and material to be used in the mine are taken from the cage at this place. Also, a similar enlargement of shaft or level to receive a balance-bob (bob-station), pump (pump-station), or tank (tank-station) (Raymond).
2. In surveying, the point at which the instrument is planted or observations are made. (Webster)
3. Any fixed point underground beyond which naked lights may not be carried. 4. Any fixed point in a mine where deputies or foremen meet to report upon the condition of their respective districts. 5. An opening into a level heading out of the side of an inclined plane. (Gresley)

Stationary motors. Motors installed in a permanent manner. (Clark)

Station pump. A mine pump permanently placed, as distinguished from a movable sinking-pump. (Weed)

Station tender. A cage tender.

Statuary marble. A pure white saccharoidal marble used for sculpture. The finest varieties are now brought from the Apuan Alps. (Merrill)

Staurolite. Iron-aluminum silicate, $Fe(AlO)_4(Al,OH(SiO_4)_2$. Sometimes used as a gem (U. S. Geol. Surv.) Called also Granatite; Grenatite; Staurotide; Xantholite.

Stauroscope. A modified polariscope used to find the position of planes of light vibration in sections of crystals. (Webster)

Staurotypous. In mineralogy, having cross-like markings. (Standard)

Stave. A wedge-shaped section placed around the die of a stamp to take up the side wear. (Richards, p. 120)

Stay (Eng.). A prop, strut or tie for keeping anything in its place. (C. and M. M. P.)

Steady. A support for blocking up a stone that is to be worked. (Standard)

Steam. Water in the form of vapor; aqueous vapor; especially the gas into which water is changed by boiling; transparent until it begins to condense. (Standard)

Steamboat coal. In anthracite only, coal small enough to pass through bars set 6 to 8 inches apart, but too large to pass through bars from 3½ to 5 inches. Steamboat coal prepared at different collieries varies considerably in size. Comparatively few collieries prepare steamboat coal except to fill special contracts or orders. (Chance)

Steamboat rolls. Those rolls in an anthracite breaker which are set farthest apart to break the coal into steamboat coal. (Standard)

Steam coal. Coal suitable for use under steam boilers. (Webster)

Steam dredger. A dredging machine operated by steam. (Century)

Steam gas. Highly superheated steam. (Webster)

Steam jet. 1. A blast of steam issuing from a nozzle. (Century)
2. A system of ventilating a mine by means of a number of jets of steam at high pressure kept constantly blowing off from a series of pipes in the bottom of the upcast shaft. (Gresley)

Steam metal. Any copper alloy specially designed to endure exposure to steam. (Webster)

Steam navvy (Eng.). A steam shovel. (Webster)

Steam point. *See* Point, 5.

Steam shovel. An excavating machine in which a large scoop is operated by steam power (Standard). Used for stripping purposes and in open pit mining, especially for iron and coal. A similar shovel is now operated by electricity.

Steam stamp. A crushing machine consisting of a vertical stamp-shaft which is forced down to strike its blow, and lifted up preparatory to striking the next, by a steam piston. (Richards, p. 113)

Steatite; Soapstone. A massive variety of talc; a very soft rock having a soapy or greasy feel; it is a hydrous magnesium silicate.

Steatitic. Of or pertaining to steatite or soapstone; made of steatite. (Century)

Steel. Formerly, a variety of iron intermediate between cast-iron and wrought-iron, very tough, and, when tempered, hard and elastic; now applied also to ingot iron, or nearly pure iron made by fusion processes. Steel is conveniently classified into three grades of hardness for commercial purposes: *mild*, or *soft steel*, containing less than 0.15 per cent of carbon; *medium steel*, containing from 0.15 to 0.30 per cent of carbon; *hard steel*, containing more than 0.30 per cent of carbon. Soft steel is highly ductile and is used for boiler plates, etc. Medium steel is used especially for constructional purposes. Hard steel is employed for rubbing surface and where great ultimate strength is required, as for axles, shafts, tools, springs, etc. A very soft kind of mild steel, used especially for making rivets is called Rivet steel (Webster). *See also* Ferroalloy.

Steel band (Ill.). A thin band or layer of pyrite in a coal seam. Also called Sulphur; Brasses.

Steel boy. A boy who carries drills to the miners, and collects dull drills and sees that they are returned to the blacksmith shop.

Steel bronze. Same as Bronze steel. (Standard)

Steele; Steele dry table. *See* Sutton.

Steel iron. A mixture of iron and steel; imperfectly made steel. (Standard)

Steel jack. Sphalerite. (Power)

Steelmaster. A steel manufacturer. (Standard)

Steel mill. 1. A mill where steel is manufactured. (Webster)
2. (Eng.) An early type apparatus for obtaining light in a fiery mine. It consisted of a revolving steel wheel, to which a piece of flint was held, to produce sparks. *See* Flint mill. (Gresley)

Steel needle. An instrument used in preparing blasting holes, before the safety fuse was invented. (C. and M. M. P.)

Steel nipper. *See* Nipper, 1.

Steel ore. A name given to various iron ores and especially to siderite, because it was supposed to be especially adapted for making steel by the earlier and direct process. (Century). *See also* Stahlstein

Steel press. A hydraulic press for compressing or condensing molten steel in molds and thus producing dense ingots or castings. (Standard)

Steelworks. A plant where steel is made. (Standard)

Steening; Steining. The brick, or stone lining of a shaft. (Gresley)

Steep. *See* Brasque.

Steep seams. *See* Edge coal; *also* Rearers. (Gresley)

Steer (Leic.). Steep; highly inclined; dips fast. (Gresley)

Steg the cleek (Scot.). To retard or stop the winding; to stop the work. (Barrowman)

Steigher (Pr.). *See* Fireman. One who has the supervision of only a fixed part or district of a mine. (Gresley)

Steining. The brick or stone lining of a shaft to prevent the loose strata of the sides from falling. (Gresley)

Steinmannite. A variety of galena that has part of the lead replaced with antimony and arsenic. (Standard)

Stellar coal. *See* Stellarite.

Stellarite. A variety of asphaltum, called also Stellar coal, because stars of fire drop from it when burning. (Chester)

Stellated. Resembling a star; pointed or radiated like a star (Webster). Frequently applied to minerals.

Stellite. An alloy of cobalt and chromium in which the constituents may vary from 10 to 50 per cent chromium with a corresponding variation in cobalt. (Min. and Sci. Press, vol. 115, p. 651)

Stem. 1. The vertical rod or shaft of wrought iron which carries the stamp at its lower end. Also called Shank. 2. The handle of the hammer. (Raymond)
3. The heavy iron rod to which the bit is attached in deep drilling by the rope method. (Steel)
4. Frequently used as a synonym for Tamp. *See* Stemming.
5. (Corn.) A day's work. (Min. Jour.) Also Stemmyn.

Stemmer. 1. (Newel) A tamping bar. (Raymond)
2. A blasting needle. (Standard)

Stemming. A term applied in mining literature to the inert material used on top of a charge of powder or dynamite, while *tamping* is reserved to indicate only the process of compressing the stemming in place. *See* Tamping. (U. S. Bu. Mines, Bull. 17, p. 45)

Stemmyn (Corn.). *See* Stem, 5.

Stempel; Stemple. 1. (Derb.). One of the cross-bars of wood placed in a mine-shaft to serve as steps. 2. A stull-piece. 3. A cap, both sides of which are hitched instead of being supported upon legs. *See* Stull. (Raymond). Also spelled Stimple.

Stemple. *See* Stempel.

Stence (Eng.). Timber for supporting a roof. (Bainbridge)

Stencil. A substance laid on parts of the surface of a piece of pottery which is to be decorated by the transfer process, to keep the oil used from adhering to those parts; hence, the pattern made by such material. (Standard)

Stent. 1. (Eng.) Rubble, waste. (Power)
2. Extent or limit, as of a pitch or bargain (Standard). *See* Pitch, 1.

Stenting (No. of Eng.). *See* Stenton.

Stenton (Newc.). A passage between two winning headways. A stenton wall is the pillar of coal between them (Raymond). Also called Stenting.

Stenton wall (Newc.). The pillar of coal between two working headings. (Min. Jour.)

Step. 1. (Eng.) The cavity in a piece for receiving the pivot of an upright shaft or the end of an upright piece.
2. The shearing in a coal face. (C. and M. M. P.)
3. (Scot.) A hitch or dislocation of the strata. (Barrowman)

Step banks (So. Wales). Working places at regular distances along the face of the long-wall system. (Gresley)

Step-cut. A mode of cutting gems in step-like facets. (Standard)

Step fault. A series of parallel faults forming steps (Power). *See* Fault.

Step grate. A grate made in steps or stairs, to promote completeness of the combustion of the coal burned upon it. (Raymond)

Stephanite; Brittle silver ore. Silver-antimony sulphide, $5Ag_2S.Sb_2S_3$. Contains 68.5 per cent silver. (U. S. Geol. Surv.)

Stepping (No. of Eng.). The system of working a face of coal in advance of the one next to it. (Gresley)

Step reef. *See* Step vein.

Step socket. A special form of socket for use on locked-wire rope. (C. M. P.)

Steptoe. An island of bedrock in a lava flow. (Lahee, p. 322)

Step-up. 1. *See* Transformer. 2. Designating a gear or gearing that increases a velocity ratio. (Webster)

Step vein. A vein alternately cutting through the strata of country-rock, and running parallel with them (Raymond). Called Step reef in Australia.

Stercorite. Microcosmic salt, $HNa(NH_4)PO_4+4H_2O$. Native salt of phosphorous. (Dana)

Stereogram. A stereographic projection of a crystal. (A. F. Rogers)

Stereographic projection. In mineralogy, a projection made on a plane through the center of a sphere by projectors from the south pole. (A. F. Rogers)

Stereotype metal. An alloy resembling type metal, but containing more lead, suitable for stereotype plates. (Standard)

Sterile coal (Eng.). Black shale or clay on top of a coal seam. (Gresley)

Sterlie (Scot.). A drum or wheel on a self-acting incline. (Barrowman)

Sterling. Having a standard of value or fineness established by the British government; said of British money of account and of gold and silver; as, pounds *sterling; sterling* plate. (Standard)

Sternbergite. A silver-iron sulphide, $Ag_2S.Fe_2S_3$. Sulphur 30.4, silver 34.2, iron 35.4. (Dana)

Sterny (Scot.). Rough; coarse-grained or crystalline, *e. g.*, sterny limestone. (Barrowman)

Sterro metal. An alloy of copper 3 parts, zinc 2, and a small proportion of iron and tin; stronger than gun metal. (Standard)

Stetefeldite. A somewhat uncertain compound containing silver, copper, iron, antimony, sulphur, and water. (U. S. Geol. Surv.)

Stetefeldt furnace. A furnace for the chloridizing-roasting of silver ores and also for roasting fine copper ores low in sulphur. Provision is made for an auxiliary fireplace. (Peters, p. 173)

Steward (York.). An underground foreman. (Gresley)

Stey (Scot.). Steep; highly inclined. (Barrowman)

Stibiconite. Antimony ocher. Hydrous oxide of antimony, Sb_2O_4,H_2O. Contains 74.5 per cent antimony (U. S. Geol. Surv.). Called also Stiblite.

Stibium. Antimony: so called in pharmacy and old chemistry. (Standard)

Stibnite. Antimony glance; gray antimony; antimony sulphide, Sb_2S_3. Contains 71.4 per cent antimony. (U. S. Geol. Surv.)

Stick (Eng.). To cease work in order to obtain an increase, or prevent a reduction of wages (G. C. Greenwell). To strike.

Stickings (Eng.). Thin veins of ore, or thin seams of clay in ore veins. (Bainbridge)

Sticking scrins (Eng.). Small veins that do not afford shoulder room. (Hunt)

Sticky coal (Ark.). Coal strongly adhering to a hard stratum of rock above or below it; also called Frozen coal. (Steel)

Stiffener (So. Wales). A door for regulating the ventilation. (Gresley)

Stiff-mud process. A plastic method of molding brick by forcing the clay through a die. (Ries)

Stifle. 1. (Scot.) Noxious gas resulting from an underground fire. (Barrowman)
2. To suffer difficulty in breathing, or to be oppressed, as by reason of air charged with smoke or other impurities. (Webster)

Stilbite; Desmine. A common mineral of the zeolite group; a hydrous silicate of aluminum, calcium, and sodium. (Dana)

Still. 1. An apparatus in which a substance is changed by heat, with or without chemical decomposition, into vapor, which vapor is then liquefied in a condenser and collected in another part of the apparatus. (Standard) A retort.
2. A house where liquids are distilled. 3. A vessel in which manganese dioxide is treated with hydrochloric acid to form a bleaching liquor. (Webster)

Still coke. The residue left in the still on distilling crude shale-oil to dryness. (Bacon)

Still grease. The amorphous distillate from the end of the crude-oil and heavy-oil distillation in the shale-oil industry. (Bacon)

Stillen (Corn.). *See* Astyllen.

Stilling. 1. (No. of Eng.) The walling of a shaft within the tubbing above the first hard stratum underlying quicksand. (Gresley)
2. A stand, as for holding vats or casks, or for unburned pottery while it is drying. (Standard)

Stilpnosiderite. Same as Limonite. (Standard)

Stilt. 1. In ceramics, a piece of hard, fired clay, or of iron, used to keep articles apart in a kiln; also called Spur. 2. Any of the piles forming the back of the sheet piling for a starling. (Webster)

Stimples (So. Wales). Small timbers. *See* Lacing; *also* Stempel.

Stink coal. A hydrocarbon mineral found in lignite. *See* Dysodile.

Stink damp. Sulphuretted hydrogen, H_2S.

Stinkquartz. A variety of quartz, which emits a fetid odor when struck. (Chester)

Stinkstone. 1. A fetid limestone. 2. (Tenn.) Bowlders of phosphate rock. (Power)
3. Any stone which emits a fetid smell on being struck or rubbed, owing to the decomposition of organic matter; specifically, anthraconite (Webster). Called also Swinestone. *See* Bituminous limestone.

Stint. 1. (Mid.) A measure of length by which colliers mine coal. 2. (Glouc.) A certain number of trams filled per man per day. 3. (So. Staff.) A collier's day or shift.

4. (Brist.) To fix upon, or agree to, a certain number of trams being filled per stall per day. (Gresley) 5. (Aust.) The amount of work to be done by a man in a given time. (Power)

Stirian. An early name for nickel-bearing marcasite. (Chester)

Stirrup (Eng.). A screw joint suspended from the brakestaff or spring-pole, by which the boring rods are adjusted to the depth of the borehole (Gresley). Also called Temper screw.

Stitch. To fasten a timber by toe nailing. (C. and M. M. P.)

Stithe (Eng.). Choke damp; after damp; black damp. *Also* Stythe. (Century)

Stob (Eng.). A long steel wedge used in bringing down coal after it has been holed. (Gresley)

Stob-and-feather (Eng.). *See* Fox wedge.

Stock. 1. (Eng.) Coal (or ore) stored at surface during slack trade, or in reserve for an extra demand at any time. 2. The average tonnage sent out of a working place in one day. (Gresley)
3. In quarrying, the useful rock as distinguished from the waste. (Gillette, p. 7)
4. The mixture of ore, coke, and limestone charged into the furnace, or stored in bins at the stock house. (Willcox)
5. An irregular, metalliferous mass in a rock formation; as a stock of lead ore in limestone. 6. A body of igneous rock intruded upward into older formations. In ground plan a stock is circular or elliptical, but in cross section it may increase downward. 7. A core of small wet coal, with a hole through for the air blast, made between the tuyère and the front of a forge. 8. A holder for a threaded die. 9. The capital of a company or corporation in the form of transferable shares, each of a certain amount. (Webster)
10. A grade of bricks; in England, a gray or red brick for an exterior wall. (Standard)

Stock brick; Kiln-run brick. A class of bricks embracing all hard enough for the outside of buildings, divided into *hard, common building, paving, hard building, outside, hard red, strictly hard, select hard, rough hard, hard washed, kiln-run hard,* and *common hard brick.* (Standard)

Stock dumper. *See* Trestle man.

Stock-house man. A general term for anyone working in stock house. (Willcox) *See* Stock, 4.

Stocking end. 1. (Lanc.) The inner end of a heading at a short distance from which there is a depression in the seam, which has become more or less filled with water, causing the ventilation to be cut off. 2. (Leic.) A Geordie. (Gresley)

Stock-pile. The ore accumulated at the surface when shipping is suspended (Standard), as on the Iron ranges of Michigan and Minnesota during the winter months.

Stock unloader. A laborer who unloads ore, coke, or stone from cars on trestle. (Willcox)

Stockwork (Germ., Stockwerk). An ore deposit of such a form that it is worked in floors or stories. It may be a solid mass of ore, or a rock mass so interpenetrated by small veins of ore that the whole must be mined together. Stockworks are distinguished from tabular or sheet-deposit (veins, beds), which have a small thickness in comparison with their extension in the main plane of the deposit (that is, in strike and dip) (Raymond). *See* Stock, 5 and 6.

Stoke hole. A hole, as in a reverberatory furnace, for introducing a rabble or other tool for stirring. (Standard)

Stolzite. A native lead tungstate, $PbWO_4$, near scheelite in form. (Webster)

Stomp. 1. (Mid.) To set a prop or sprag with one end in a slight hole cut out of the floor or roof to receive it. 2. A short wooden plug fixed in the roof, to which lines are hung, or to serve as a bench mark for surveys. (Gresley)

Stone. 1. Concreted earthy or mineral matter. A small piece of rock. Rock or rocklike material for building. Large natural masses of stone are generally called rocks; small or quarried masses are called stones; and the finer kinds, gravel or sand. 2. A precious stone; a gem. (Webster)
3. (Eng.). Ironstone, *which see.* (Gresley)

4. (Aust.) Ore sent to mill. (The Englishman uses the term "mill-stuff" and the Colorado-Cornishman "mill-dirt.") In southwest Missouri lead and zinc mines the term "dirt" is used, while in Michigan copper mines "rock" is the common expression. (Rickard)

Stone ax. A stone-cutter's ax. (Standard)

Stone bind. A variety of sandstone. (Power)

Stone boat. 1. A flat runnerless sledge or drag for transporting stone or other heavy material. (Webster) 2. A wheeled vehicle having slung below the axles a platform for hauling stones. (Standard)

Stone brash. Land abounding in stones, especially a subsoil of small stones or finely broken rock. (Webster)

Stone breaker. A stone crusher.

Stone brick. A hard brick or fire brick made in Wales. (Webster)

Stone butter. 1. A variety of halotrichite. Called also Rock butter. (Standard) A sort of alum. 2. A kind of clay said to have been used instead of butter. (Chester)

Stone coal (Wales). 1. Anthracite, in lumps. Also certain other very hard varieties of coal. (Gresley) 2. Mineral coal, as distinguished from charcoal. (Standard)

Stone crusher. A machine for breaking stones, as for road building. When used for breaking ore, called Ore crusher. (Standard)

Stone cutter. 1. One whose occupation is cutting stone, as for building. 2. A gem cutter. 3. A machine for facing stone. (Standard)

Stone dresser. 1. One who smooths and shapes stone. 2. A machine for dressing and finishing building stones, etc. (Standard)

Stone drift (Aust.). A passage driven in rock instead of coal. (Power)

Stone flax. An early name for asbestos. (Chester)

Stonegall. A clay concretion found in certain sandstones. (Standard)

Stone hammer. A hammer for breaking or for dressing stone. (Standard)

Stonehead (Eng.). 1. A heading driven in stone or bind. A stone drift. 2. (No. of Eng.) The first hard stratum underlying quicksand. (Gresley)

Stone land. Land chiefly valuable for stone, as sandstone, limestone, granite, etc. (U. S. Min. Stat., pp. 1308–1833).

Stoneman. 1. (No. of Eng.) One who is employed in driving a stonehead, or who rips, timbers, and repairs roads. *See* Brusher. (Gresley) 2. (Aust.). A man who works in rock, in contradistinction to one who works in coal. (Power)

Stone mill. 1. A stone crusher. 2. A machine for dressing and finishing marble, slate, etc.; a stone dresser. (Standard)

Stone mine. 1. (Scot.) An ironstone mine or working. (Gresley)) 2. (Scot.). A mine driven in barren strata. (Barrowman)

Stone ocher. Ocher found in hard, globular masses. (Webster)

Stone of ore. A piece of ore. (Roy. Com.)

Stone oil. Rock oil; petroleum. (Webster)

Stone pit. A quarry where stones are dug. (Webster)

Stone pitch. Pitch that is hard like stone. (Webster)

Stone quarry. A place where stone is quarried. (Standard)

Stone saw. A stone-cutting apparatus having no teeth, being a simple iron band fed with sand and water, cutting by attrition. (Standard)

Stone squarer. A workman who squares or shapes stones, as for building. (Standard)

Stone tubbing. Water-tight stone walling of a shaft cemented at the back. (C. and M. M. P.)

Stoneware. A variety of pottery. (Standard)

Stonework. 1. Any work directly concerned with the shaping, preparation, setting, or the like, of a stone or stones. (Webster) 2. (Scot.) Driving of drifts or galleries in stone or rock. *See* Stonehead, 1. (Gresley)

Stone works. 1. An establishment for cutting stone, as marble. 2. A pottery for making stoneware. (Standard)

Stone yard. A yard in which stones are cut, shaped, broken or the like. (Webster)

Stone yellow. Yellow ocher. (Webster)

Stock (No. of Eng.). A pillar of coal about four yards square, being the last portion of a full-sized pillar to be worked away in bord-and-pillar workings. (Gresley)

Stock-and-feather (Eng.). A wedge for breaking down coal, worked by hydraulic power, the pressure being applied at the extreme inner end of the drilled hole. (Gresley)

Stooled (Eng.). Applied to a vein cut vertically for some distance. (Bainbridge)

Stool end. A supporting pillar of rock. (Webster)

Stool pipe; Stool piece (Scot.). The pipe on which a column of pipes rests. (Barrowman)

Stoop (Scot.). A post or pillar; a boundry post; a support or prop, as a pillar of coal left to support the roof. (Webster)

Stoop and room; Pillar and stall; or Post and stall (Scot.). A system of working by which mineral is extracted from its bed in a series of galleries or rooms leaving pillars or stoops to support the roof. (Barrowman)

Stoop and thirl (Scot.). An old name for Stoop and room. (Barrowman)

Stooped (Scot.). Said of a mine when the pillars or stoops have been extracted. (Barrowman)

Stooped waste (Scot.). Stoop-and-room workings where the pillars have been worked out. (Barrowman)

Stooping (Scot.). The process of extracting stoops or pillars. (Barrowman)

Stoop road (Scot.). A road driven in the solid coal in connection with the stoop-and-room system of mining. (Gresley)

Stop. 1. Any cleat or beam to check the descent of a cage, car, pump rods, etc. (Chance)
2. In mining, a variation of stope.

Stope. 1. An excavation from which the ore has been extracted, either above or below a level, in a series of steps. A variation of step (Standard). Usually applied to highly inclined or vertical veins. Frequently used incorrectly as a synonym of room, which is a wide working place in a flat mine.
2. To excavate ore in a vein by driving horizontally upon it a series of workings, one immediately over the other, or *vice versa*. Each horizontal working is called a stope (probably a corruption of step), because when a number of them are in progress, each working face being a little in advance of the next above or below, the whole face under attack assumes the shape of a flight of stairs. When the first stope is begun at a lower corner of the body of ore to be removed, and, after it has advanced a convenient distance, the next is commenced above it, and so on the process is called *overhand* stoping. When the first stope begins at an upper corner, and the succeeding ones are below it, it is *underhand* stoping. The term stoping is loosely applied to any subterranean extraction of ore except that which is incidentally performed in sinking shafts, driving levels, etc., for the purpose of opening the mine. (Raymond)

Stoper. A stoping drill.

Stoping. 1. In geology, the enlargement of a magmatic chamber through the breaking off of blocks of rock from the walls and roof: one of the processes by which large bodies of intrusive igneous rock are supposed to acquire the space which they occupy upon solidification. (La Forge)
2. *See* Stope, 2.

Stoping and filling. *See* Overhand stoping.

Stoping drill. A small air or electric drill, usually mounted on an extensible column, for working stopes, raises, and narrow workings.

Stoping ground. Part of an orebody opened by drifts and raises and ready for breaking down. (Weed)

Stoping in horizontal layers. *See* Overhand stoping.

Stoping underhand. Mining a stope downward in such a series that presents the appearance of a flight of steps. (Ihlseng)

Stop-off. 1. To close off a part of a mine by means of a brattice, wall, stopping, etc.
2. In founding, to fill part of a mold with sand or earth, to prevent access of molten metal to that part. (Standard)

Stoppages (Eng.). Deductions from miners' wages, such as rent, candles, blacksmith's work, field club, etc. (Gresley)

Stopper hole. In a puddling furnace, the hole through which the rabble is introduced. (Webster)

Stopping. A brattice, or more commonly, a masonry or brick wall built across old headings, chutes, airways, etc., to confine the ventilating current to certain passages, and also to lock up the gas in old workings, and in some cases to smother a mine fire. (Chance)

Storage battery. A combination of secondary cells or accumulators which when once charged may be used for a considerable time after as a source of electric current. (Century) There are a number of types and makes. Large ones find use in operating mine-haulage motors, while a portable type is used in the electric safety lamp.

Storage battery locomotive (or motor). A mine haulage-motor operated by self-contained storage batteries.

Stoss. In geology, facing the direction whence a glacier moves, as a rock or hill in its track; as, the *stoss side* of a crag; contrasted with *lee*. (Standard)

Stove. 1. The oven in which the blast of a furnace is heated. (Raymond) 2. A kiln, as for firing pottery or drying minerals. (Webster)

Stove coal. In anthracite only; two sizes of stove coal are made—Large and Small. *Large Stove*, known as No. 3, passes *through* a 2¼ inch mesh and *over* a 1¾ inch to 1½ inch mesh; *Small Stove*, known as No. 4, passes *through* a 1¾ inch to 1⅝ inch mesh and *over* a 1⅛ inch to 1 inch mesh. (Chance)

Stove distillate. A stove gasoline before receiving a finishing treatment. (Bacon)

Stove gasoline. Gasoline used for gasoline stoves and for making illuminating gas. (Bacon)

Stove glass. Mica for use in stoves. (Standard)

Stove pipe. Riveted well casing. (Redwood)

Stove tender; Hot-blast man. One who puts stoves on gas or on blast, regulates temperatures of blast; handles gas at shutdowns; usually watches water from tuyères, plates, etc., at iron blast-furnaces. (Willcox)

Stow. 1. To pack away rubbish into goaves or old workings. (Steel) 2. (Prov. Eng.) The structure containing the furnace and series of pots used in tin plating. (Standard)

Stower (Aust.). One who stows away waste in old workings. (Power)

Stowage (Scot.). In longwall mining the space from which the mineral has been extracted and which has been filled with waste. (Barrowman)

Stowbord (Newc.). A place into which rubbish is put (Raymond). *Also* Stowboard.

Stowce. 1. A windlass. 2. (Derb.) A wooden landmark, placed to indicate possession of mining ground (Raymond). *Also* Stowse.

Stowing. A method of mining in which all the material of the vein is removed and the waste is packed into the space left by the working. (Raymond)

Stow road (Scot.). An abandoned road in which waste is stowed. (Barrowman)

Stowse (No. of Eng.). A windlass (Gresley). *Also* Stowce.

Straddle. A vertical mine-timber, especially one supporting a set in a shaft.

Straddle pipe. In gas manufacture, a bridge pipe connecting the retort with the hydraulic main. (Century)

Strahlite. Same as Actinolite. Also spelled Stralite. (Standard)

Straight bit (Eng.). A flat or ordinary chisel for boring. (Gresley)

Straight coal (So. Staff.). An excavation made in thick coal, having the solid coal left on three sides of it (Gresley). Also called Straight stall.

Straight-cut gang frame. In quarrying, a saw gang which slides back and forth on a bed, as contrasted with the ordinary saw gang which swings back and forth when suspended from above. (Bowles)

Straight dynamite. A high explosive consisting essentially of 20 to 60 per cent nitroglycerin and an active base or absorbent. (Du Pont)

Straight-ends-and-walls (No. Wales). A system of working coal somewhat similar to bord-and-pillar. (Gresley)

Straightening press. A power-press to straighten iron and steel bars, such as rails, shafting, etc. (Raymond)

Straight point (Aust.). That straight portion of the inner main rail between the rails of a turn-out. (Power)

Straight stall. A lateral excavation into a thick seam, having coal on the face and both sides (Standard). Also called Straight coal.

Straight-work; Strait-work (Eng.). The system of mining coal by headings or narrow work. (Gresley)

Strain. A change of shape produced in a body. (Stress and strain are often used incorrectly as synonymous terms). (C. M. P.)

Strain breaks. Fractures occurring in rock quarries where the rock is under compressive stress. This stress is relieved locally in the process of quarrying, resulting in the rending or fracturing of the rock mass. (Bowles)

Strain sheet. 1. A skeleton drawing of a structure, as a roof truss or a bridge, showing the stress to which each member will be subjected. (Webster)
2. A quarryman's term for granite sheets produced by compressive strain. (Perkins)

Strait (Scot.). Narrow; in the solid (Barrowman). *See* Straight-work.

Straits tin. Tin from the Strait of Malacca and the islands of Banka and Billiton, Dutch East Indies.

Strake. 1. (Corn.) A trough for washing broken ore, gravel, or sand. A launder. (Webster)
2. The place where ore is assorted on the floor of a mine; a dressing floor. (Standard)

Strand. A varying number of wires or fibers twisted together; the strands in turn are twisted together, forming a rope. (C. M. P.)

Strap. 1. (Scot.). A plank supported at each end to make the roof strata secure. (Barrowman)
2. (Mid.) An old iron rail put up between the coal face and the front row of props, in longwall stalls, for supporting a weak roof. (Gresley)

Strapping plate (Corn.). One of the wrought-iron plates by which the spears of a pump rod are bolted together; a spear plate. (Century)

Strap rope (Aust.). An endless rope that transmits power from the surface into the clutch room underground, where the various district ropes are thrown into gear. (Power)

Strata. Plural of *stratum*.

Strath. 1. A broad valley, as distinguished from a glen or gorge; it may not be the valley of a single stream.
2. A broad valley with a planated floor which is a local or incipient peneplain. (La Forge)

Strath stage. That stage in the peneplanation of a region when the main streams have carved broad valleys with planated floors graded to the same regional base level. (La Forge)

Stratic. Of, pertaining to, or designating the order or sequence of strata; strategraphic. (Webster)

Straticulate. Having numerous thin layers, either (1) of sedimentary deposition, as by oscillation or wave-motion, often somewhat oblique to the main layers of stratification, or (2) of deposition from solution, the layers being often those of color or structure and not of fissility, as in banded agate. (Standard)

Stratification. The deposition of sediment beds, layers, or strata; hence, the arrangement of rocks in such beds, layers, or strata; hence, further, the stratified structure resulting from such deposition and arrangement. (La Forge)

Stratification-foliation. The segregation of certain minerals in thin, irregular, discontinuous laminæ, in planes parallel to the bedding or stratification. (Standard)

Stratification planes. Continuous divisional planes of great extent, marking changes in the character of material or the mode of deposition, and the presence of fossils generally arranged in planes parallel to the plane of deposition and with their broader surfaces lying in the same planes. (Standard)

Stratified. Formed or lying in beds, layers, or strata. (La Forge)

Stratigrapher. One who studies, or who has expert knowledge of, stratigraphy. (Webster)

Stratigraphic geology. *See* Geology.

Stratigraphic throw. The distance between the two parts of a disrupted stratum measured at right angles to the plane of the stratum. (Lindgren, p. 129)

Stratigraphy. 1. That branch of geology which treats of the formation, composition, sequence, and correlation of the stratified rocks as parts of the earth's crust. 2. That part of the descriptive geology of an area or district which pertains to the discrimination, character, thickness, sequence, age, and correlation of the rocks of the district. (La Forge)

Stratum. A bed or layer of rock; *strata*, more than one layer. (Roy. Com.)

Stratum plain. A plain that has been reduced approximately to the surface of a level or nearly level resistant stratum which has served as a local base level. (La Forge)

Straw (Eng.). A straw or reed filled with gunpowder, and used as a fuse. (Gresley)

Streak. The color of the powder of a mineral as obtained by scratching the surface of the mineral with a knife or file or, if not too hard, by rubbing it on an unpolished porcelain surface. (Dana)

Streaked. Having some of the mineral constituents so arranged as to give the rock a striped or streaked appearance. In the eruptive rock this structure is often produced by the flowing of the mass in a partially cooled condition. It is best seen in obsidian, rhyolite, and quartz porphyries. (Merrill)

Streak plate. A piece of unglazed porcelain for testing the streak of minerals.

Stream (Corn.). To separate or clean ore by washing.

Stream-down sluice. A sluice box placed to receive the material rejected from the tables of a dredge. (Weatherbe)

Streamer. 1. (Corn.) A searcher for stream tin. (Raymond)
2. One who washes out stream tin. (Webster)

Stream gold. Gold in alluvial deposits; placer gold. (Webster)

Streaming. 1. Separating ore from gravel by the aid of running water. (Skinner)
2. The working of alluvial deposits for the tin found in them. 3. The washing of tin ore from the detrital materials. 4. The reduction of stream tin. (Standard)

Stream tin. Tin ore (cassiterite) occurring in stream beds; distinguished from Lode tin. (Skinner)

Stream wheel. A wheel used to measure the velocity of flowing water in which it dips. (Webster)

Stream works. 1. (Corn.). A name given by miners to alluvial tin deposits usually worked in the open air. (Ure)
2. A place where ore, generally tin ore, is washed from alluvial deposits. (Standard)

Strebbau (Ger.). The longwall system of coal mining. (Gresley)

Streck (Eng.). A signal word for the whim or tackle to be lowered. (Hunt) *Compare* Strick.

Strek (Corn.). A trough for washing tin ore (Davies). A variation of strake.

Stress. A force or combination of forces tending to change the shape of a body. (C. M. P.)

Stret. 1. (Mid.) Solid, close, compact; as gobbed stret, packed stret, etc. (Gresley)
2. The system of mining coal by headings or narrow work. *See* Bord-and-pillar (C. and M. M. P.). Also spelled Strett.

Stretch. A particular direction or course; as, the *stretch* of a coal seam. (Standard)

Stretcher. 1. A brick or stone laid with its length parallel to the face of the wall. (Ries)
2. (York.) A prop or sprag.

Stretcher bar. A single-screw column capable of holding one machine drill; is used in small drifts. (Gillette, p. 96)

Stretcher bond. A form of bond in which the bricks or ashlar are laid lengthwise in successive courses, so that the joints of one course are at the middle of those of the adjacent courses. (Standard)

Stria. A minute groove or channel. A threadlike line or narrow band (Webster). *See* Glacial stria.

Striated. Marked with parallel grooves or striæ. (Raymond)

Striations. 1. Very fine parallel lines marking the surfaces or cleavage faces of minerals. (George)
2. Channels or scratches made in rock-scoring. (Standard)

Strick (Corn.). To let a man down a shaft by a windlass. (Davies) *Compare* Streck.

Striding level. A spirit-level, the frame of which carries at its two extremities inverted Y's below, so that it may be placed upon two concentric cylinders and straddle any small intervening obstacles. (Century)

Strike. 1. The course or bearing of the outcrop of an inclined bed or structure on a level surface; the direction or bearing of a horizontal line in the plane of an inclined stratum, joint, fault, cleavage plane, or other structural plane: it is perpendicular to the direction of the dip. (La Forge) *Compare* Trend.
2. To find a vein of ore; a valuable discovery. 3. In iron-working, a puddler's rabble. 4. Act of quitting work by mutual understanding by a body of workmen as a means of enforcing compliance with demands on their employer; a stopping of work by workmen to obtain or resist a change in conditions of employment. *Compare* Lockout. (Webster)
5. A hoisting-hook for metal, in a foundry. 6. A straight-edged implement for leveling something as clay in a brickmaker's or potter's mold, or sand in a founders' mold, by scraping off the superfluous portion on top; a strickle. 7. In masonry, to wipe off the projecting fresh mortar from (a joint). (Standard)

Strike a lead. To come upon or discover a lead, lode, or vein, as of ore (Standard). *See* Strike, 2.

Strike board; Strike tree (Scot.). A board at the top of a shaft from which the bucket is tipped; used in shaft sinking. Formerly the beam or plank at the shaft-top on which the baskets were landed. (Barrowman.)

Strike cut. In separating blocks of stone in a quarry, the cut that is parallel to the strike of the rock strata. (Bowles)

Strike fault. *See* Fault.

Strike joint. A joint parallel to the strike. (Gresley)

Striker. 1. A blacksmith's helper. 2. A workman who dresses off the clay bricks with a strickle in molding. (Webster)
3. (Derb.) The man who lands the kibble, corf or bucket at the top of a shaft. (Mander) *See* Strike board.

Striker-off. In brickmaking, a striker or capper. (Standard)

Strike-shift. The horizontal component of the shift parallel to the fault strike. (Lindgren, p. 122)

Strike-slip. The component of the slip parallel with the fault-strike, or the projection of the net slip on a horizontal line in the fault surface. (Lindgren, p. 121)

Strike-slip fault. *See* Fault.

Strike tree. *See* Strike board.

Strike valley. A valley parallel to the strike of associated rock beds. (Webster)

Striking deals (Eng.). Planks fixed in a sloping direction just within the mouth of a shaft, to guide the bucket to the surface. (Gresley)

Striking hammer. A quarryman's (or miner's) hammer for striking a rock drill. (Standard)

Striking house (Derb.). A sheltered place at the top of a shaft for the striker, or cager. *See* Striker, 3. (Mander)

Striking solution. A dilute solution of silver cyanide, containing potassium cyanide, in which articles to be silver plated are dipped before being immersed in the silver bath proper. (Standard)

String. 1. A very small vein, either independent or occurring as a branch of a larger vein (Roy. Com.). A stringer.
2. A series of well-drilling tools arranged for lowering into the hole.

Stringer. 1. A narrow vein or irregular filament of mineral traversing a rock mass of different material. (Webster)
2. A heavy timber or plank, usually horizontal, but sometimes inclined, supporting other members of a structure, and usually running in the direction of the greatest length of the collection of supported members. (Standard)

Stringer lode. A shattered zone containing a network of small nonpersistent veins (Lindgren, p. 145). Also called Stringer zone.

Stringing deals (Eng.). Thin planks, nailed to the inside of the curbs in a shaft, so as to suspend each curb from those above it. (Raymond)

String pump. A system of pumping whereby the motion of the engine is transmitted to the pump by timbers or stringers bolted together. (C. and M. M. P.)

String rods. A line of surface rods connected rigidly for the transmission of power; used for operating small pumps in adjoining shafts from a central station. (C. and M. M. P.)

Strip. 1. To remove from a quarry, or other open working, the overlying earth and disintegrated or barren surface rock. (Raymond)
2. A shallow cast ingot of brass for rolling into sheets. 3. To remove the mold from a steel ingot. (Webster)
4. To mine coal, alongside a fault, or barrier. (Gresley)
5. One of a set of troughs, or their equivalent, along which ore particles, as they come from the stamps, are deposited in the order of their specific gravity. (Standard)

Stripe. 1. (Corn.) A long, rectangular buddle. (Webster)
2. The series of bands of variation in color or texture in a rock mass, or the course of the planes of such bands, as indicative of the course of the bedding plane when that is otherwise obscure. (Standard)

Stripping. 1. An open-pit working. 2. *See* Strip, 1. 3. The earth, rock, or soil so removed. (Chance)
4. (York.) A web or portion of coal worked off all along the face of a stall. Gresley.) *See* Strip, 4.

Stripping a gutter. Removing the headings from off the wash dirt, which is left undisturbed. (Duryee)

Stripping a jig (Aust.). The forming of a jig, by enlarging a cut-through on an incline (Power). *See* Jig, 3.

Stripping a mine. 1. *See* Strip, 1. 2. Robbing a mine of its best ore.

Stripping a shaft. 1. Taking out the timber from an abandoned shaft. 2. Trimming or squaring the sides of a shaft. (Duryee)

Stripping system. The removal of the overburden and mining of the ore in one or more benches, the ore face being broken by blasting and the broken ore loaded by hand, shoveling machine, or steam shovel. The name "terrace or bench open-pit working" has been suggested. (Young)

Strip-pit. A coal or other mine worked by stripping (Steel). An open-pit mine.

Strockle. In glass manufacturing, a shovel with a turned-up edge, for grit, sand, etc. (Webster)

Stroke. In masonry, to give a finely fluted surface to. (Webster)

Stromatology. The history of the successive formations of the stratified rocks, including their fossils. (Standard)

Stromeyerite. A somewhat variable sulphide of silver and copper $(Ag,Cu)_2S$. Contains 50.2 to 52.7 per cent silver and 30.5 to 33.7 per cent copper. (U. S. Geol. Surv.)

Strong. 1. Large; important; said of veins, dikes, etc. (Webster)
2. (Scot.) Hard, not easily broken, *e. g.*, strong coal, strong blaes. (Barrowman)
3. Referring to the character of bind, meaning that the argillaceous is largely mixed with the arenaceous or siliceous material. (Gresley)

Strong lode. A large persistent lode. At Alston moor, applied to lodes lying in a fault plane in which the difference of level between similar strata is considerable. (Power)

Strontia. The monoxide of strontium, SrO, an alkaline earth which when pure is an infusible grayish white powder having an acrid, burning taste. (Century)

Strontianiferous. Containing or yielding strontium or its salts. (Standard)

Strontianite. Strontium carbonate, $SrCO_3$. (U. S. Geol. Surv.)

Strontium. A bivalent metallic element of the calcium group. In nature, always combined, chiefly in strontianite (carbonate) and celestite (sulphate). When pure it is silver-white. Symbol, Sr.; atomic weight, 87.6; specific gravity, 2.5. (Webster)

Stroup (Scot.). A spout. (Barrowman)

Struck-out (Corn.). The termination of a vein or lode by a fault. (Pryce)

Structural. Pertaining to, part of, or consequent upon the geologic structure: as a *structural* valley. (La Forge)

Structural plain. A gently sloping stratum plain. (La Forge)

Structural valley. A relatively long and narrow depression produced by the movements of the surface, as a synclinal valley. (Webster)

Structure. 1. That part of the geology of a region which pertains to the attitude of the rocks, the nature and amount, if any, of the deformation which they have undergone, and the distribution and mutual relations of the structural features. 2. In petrology, one of the larger features of a rock mass, like bedding, flow banding, jointing, cleavage, and brecciation; also the sum total of such features: contrasted with Texture, *which see.* (La Forge)

Strum. 1. (No. of Eng.) A kind of iron sieve placed round the suction pipe of a pump, to prevent stones or other rubbish passing into the pump. (Gresley)
2. (Scot.) A safety fuse. (Barrowman)

Strut. A mine prop to sustain compression, whether vertical or inclined. (C. and M. M. P.)

Stub entry. A short, narrow entry turned from another entry and driven into the solid coal, but not connected with other mine workings; a dead end.

Stub iron. Iron made from old horseshoe nails: especially valuable for making gun-barrels. (Standard)

Stucco. 1. A fine plaster made of gypsum and glue-water, or of powdered white marble and fine sand, gypsum, and water: for walls or their relief ornaments. 2. Loosely, any plaster or cement used for the external coating of buildings. 3. Plaster of Paris. (Standard)

Studdle (Corn.). 1. A prop to support the middle of a stull. 2. A distance-piece between successive frames of timbering. (Raymond)
3. The vertical members of shaft-timber sets placed at each corner and at the intersection of the dividers and the wall plates. 4. An upright prop supporting a platform in a mine, usually one of a set of four. (Standard)

Stufa. A jet of steam issuing from a fissure in volcanic regions, at a temperature often above the boiling point of water. (Comstock)

Stuff. 1. Ore associated with the gangue of a lode. (Skinner)
2. The produce of a mine, as coal and slack. (Gresley)

Stugg (Scot.). To take down coal with the pick only. (Barrowman)

Stull. 1. The top-piece of a set of mine timbers. 2. A timber prop supporting the roof of a mine opening. (Weed)
3. (Corn.) A platform (stull-covering) laid on timbers (stull-pieces), braced across a working from side to side, to support workmen or to carry ore or waste. (Raymond)

Stull dirt; Stull rock. Material supported upon the stulls. (Ihlseng)

Stull-piece. A piece of timber placed over the back of a level to be covered with lagging, to prevent rock falling into the level from the stopes above. (Standard)

Stulm (from the Ger. *Stollen*). An approximately horizontal passageway in a mine; an adit. (Webster)

Stump. A small pillar of coal left between the gangway or airway and the breasts to protect these passages; any small pillar. (Chance)

Stumping (Lanc.). A kind of pillar-and-stall plan of mining coal. (Gresley)

Stump pulling. Pillar robbing.

Stun. 1. In stone-cutting, to loosen the surface of, as stone in dressing, by blows with the edge or point of a hammer, delivered at right angles to the face. 2. A white or discolored place in marble or other stone, caused by a blow from a blunt-edged or blunt-pointed hammer. 3. A groove or scar on the sawed face of a piece of stone, caused by sand or grit between the side of the saw-blade and the stone. (Standard)

Stunning. A quarryman's term for the formation of fractures caused by the cutting bars of a channeling machine striking the rock excessively heavy blows. (Bowles)

Stup. A pulverized mixture of clay and coke or coal. Probably from the Ger. *Gestübbe.* (Raymond)

Stupp. A black deposit obtained in distilling mercury ores, consisting of a mixture of soot, hydrocarbons, mercury and its compounds, ore, dust, etc. (Webster)

Sturt (Corn.). A tribute-bargain which turns out profitably for the miner. (Raymond)

Sturtevant balanced-rolls. Rolls in which all four boxes are movable and held in position by springs. The idea is to divide the thrust whenever the springs yield and thus reduce internal stresses. (Liddell)

Sturtevant grinder. A disk grinder in which one disk is stationary and the other rotates. The stationary disk is moved out of center from time to time, so that any groove which forms can be ground out. (Liddell)

Sturtevant ring-roll crusher. A crusher similar to the Kent roller mill, *which see.* (Liddell)

Sturtevant roll-jaw crusher. A crusher in which the motion of the upper part of the jaws is like that of the Dodge crusher, while the lower parts of the jaws, of cylindrical surfaces of varying radii, grind the ore between them. (Liddell)

Stygian deposits. A general term for ore deposits formed underground by waters of atmospheric origin. (Eng. and Min. Jour. vol. 75, p. 257)

Stylolite. A small, short, columnar structure, transverse to the bedding, common in some limestones and calcareous shales and supposed to have been formed by differential vertical movement under pressure. (La Forge)

Stythe (Scot.). A miner's term for fire damp, or rather for the stifling, suffocating odor of choke damp that follows an explosion of the former (Page). Also spelled Stithe.

Sub. 1. A prefix used in chemistry to signify that the term to which it is prefixed is present in less than normal amount, or *sub*-oxide. (Webster)
2. (Mid.) Subsistence; money or wages paid on account. (Gresley)
3. Short for Sublevel in caving systems of mining.

Subaerial. Formed, existing, or taking place on the land surface: contrasted with Subaqueous. (La Forge)

Subaqueous. Formed, existing, or taking place beneath a body of water; contrasted with Subaerial. (La Forge)

Subbituminous coal. Black lignite; Lignitic coal.

Subcoastal plains. Submerged plains of the continental shelf. (Webster)

Subconchoidal. Imperfectly or indistinctly conchoidal. (Webster)

Subdivide. In geology, a divide between the tributaries of a main stream; a subordinate divide. (Standard)

Subdrifting and caving. *See* Top slicing combined with ore caving.

Subglacial. Formed or deposited beneath a glacier.

Subhedral. Bounded in part by crystal faces proper to the mineral itself and in part by surfaces formed against preexisting crystals; hypautomorphic; hypidiomorphic: said of some crystals in igneous rocks and intermediate in meaning between Euhedral and Anhedral. (La Forge)

Subhornblendic. Of or pertaining to material, as rocks that contain hornblende disseminated through their mass. (Standard)

Subindividual. One of the small crystals that often unite in parallel growths to build up larger crystals of the same general habit. (Standard)

Subjacent. Situated directly underneath; lying below; in geology, lying below a stratum or another formation. (Standard)

Subjoint. Minor joints diverging from or parallel to the regular joints. (Perkins)

Sublevel. An intermediate level opened a short distance below the main level; or, in the caving system of mining, a few feet (15–20) below the top of the ore body, preliminary to caving the ore between it and the level above. *See* Sublevel stoping; *also* Caving system of mining.

Sublevel backstoping. *See* Sublevel stoping.

Sublevel caving. *See* Top slicing combined with ore caving.

Sublevel method. *See* Sublevel stoping.

Sublevel slicing. *See* Top slicing combined with ore caving; *also* Sublevel stoping.

Sublevel stoping. A mining method involving overhand, underhand, and shrinkage stoping. Its characteristic feature is the use of sublevels. The sublevels are worked simultaneously, the lowest on a given block being farthest advanced and the "subs" above following one another at short intervals. The uppermost sublevel underneath the cover is partly caved. The caved

cover follows down upon the caved ore. The broken ore is in part drawn from the level, and a part remains in the stope in order to give lateral support to the walls and to prevent admixture of cover and ore. The breaking faces are developed by crosscuts, which are extended from wall to wall from the end of the sublevel. The method can also be looked upon as a retreating method, the ore body being worked from the top down and the individual blocks upon a given level being worked from their ends to the center (Young). Modifications of this method are: Chamber-and-pillar system; Chambers without filling; Combination of subslicing and stoping; Drift stoping; Filling system; Mitchell slicing system; Pillar robbing; Pillar robbing and hand filling; Room-and-pillar system; Square work and caving; Square work, pillar robbing, and hand filling; Sublevel back stoping; Sublevel method; Sublevel slicing system; and Substoping.

Sublimate. A coating or deposit formed in a glass tube or on charcoal as a result of heating certain minerals. (George)

Sublimation. The volatilization and condensation of a solid substance, without fusion, or without the intervening liquid stage being passed through.

Sublimation theory. The theory that a vein was filled first with metallic vapors. (Raymond)

Sublimation vein. A vein formed in accordance with the sublimation theory. (Standard)

Sublime. To pass from a solid to a gaseous state, and again condense to solid form, without apparently liquefying. (Webster)

Submarine blast. A charge of high explosives fired in bore holes drilled in the rock under water for dislodging dangerous projections and deepening channels. (Du Pont)

Submetallic. Applied to minerals having an imperfect metallic luster, as columbite, wolframite. (Dana)

Subnate. Applied to rocks formed within or below the crust. (Power)

Subporphyritic. Having, in an imperfect degree, the character of porphyry. (Century)

Subsalt. A basic salt. (Century)

Subsequent. Tributary to and subsequent in development to a primary consequent stream, but itself consequent upon structure brought out in the degradation of the region; subconsequent; said of some streams and their valleys; as a subsequent valley. (La Forge)

Subsequent deposits. A term proposed for ores which were not directly the result of igneous processes. (Eng. and Min. Jour., vol. 75, p. 258)

Subsidence. A sinking down of a part of the earth's crust. (Roy. Com.)

Subsidiary company. A company in which a majority of the shares of stock are held by another company, giving the control to the latter.

Subsilicate. A basic silicate. (Standard)

Subsilicic. Containing less than 50 per cent of silica: same as and much preferable to *basic*, which it is replacing. (La Forge)

Subslicing; Side slicing; End slicing. *See* Top slicing combined with ore caving.

Subsoil. 1. Broadly and loosely, the part of the regolith (earth mantle) which lies beneath the true soil and which contains almost no organic matter. 2. More precisely, a layer of the regolith, grading into the soil above and into unmodified rock waste below, which is less oxidized and hydrated than the soil proper and contains almost no organic matter, but is somewhat charged with and indurated by iron oxides and clay that has been leached down from the overlying soil. (La Forge)

Subsoiling. The firing of small charges of dynamite 2 or 3 feet below the surface for breaking up impervious strata of soil, clay, etc., for aerating, draining, and moistening the soil. (Du Pont)

Substalagmite. A compact, noncrystalline deposit of calcium carbonate. (Webster)

Substation. A station in which electric current is changed in character or potential. (H. H. Clark)

Substitution vein. A metalliferous vein formed through the agency of percolating waters by the partial or complete substitution of the vein material for the original rock. Called also replacement vein or deposit. (Webster)

Substoping. *See* Sublevel stoping.

Substratum. An under-layer or stratum; a stratum, as of earth or rock, lying immediately under another. (Standard)

Subterposition. The state of being placed beneath something else; specifically, in geology, the order in which strata are disposed in descending series. (Standard)

Subterrane. The bedrock beneath a surficial deposit. (La Forge)

Subterranean. Being or lying under the surface of the earth. (Webster)

Subtransparent. Of imperfect transparency. (Duryee)

Subtuberant. Having a domelike form due to igneous intrusion into the rocks beneath: said of some domes in strata and of the consequent deformation of the surface and the resultant form of the topography. (La Forge)

Subvitreous. A luster less glassy in appearance than that of common glass. (George)

Succinellite. Succinic acid, $C_4H_6O_4$, obtained in orthorhombic crystals from amber.

Succinite. 1. Amber. It occurs in irregular masses, without cleavage, possesses a specific gravity of 1.050 to 1.096, and fuses at 250° to 300° C. (Bacon). *Also called* Electrum. 2. Amber-colored grossularite. (Webster)

Succino (Sp.). Amber. (Halse)

Sucked stone (Corn.). A honeycombed or porous stone. (Pryce)

Sucker rod. The pump rod of an oil or artesian well. (Chance)

Sucking pump. A suction pump. (Standard

Suction anemometer. An anemometer that measures wind-velocity by the degree of exhaustion caused by the blowing of the wind through or across a tube. (Standard)

Suction basket. The strainer at the foot of the suction pipe of a pump or of a suction hose. (Standard)

Suction dredge. A dredge in which the material is lifted by pumping through a suction pipe (Weatherbe)

Suction pipe. That part of a pump where the water enters. (Barrowman)

Suction primer. A pump, auxiliary to a steam pump, used to exhaust the air from the main chamber, as a preliminary to the use of steam. (Standard)

Suction pump. A pump wherein, by the movement of the piston, water is drawn up into the partial vacuum formed under the retreating bucket on the upstroke, reflux being prevented by a valve in the pipe. Theoretically the suction pump will lift water 34 feet, but practically only about 26 to 28 feet. (Webster)

Sud (Prov. Eng.). Drift-sand deposited on flooded land. (Standard)

Sueldo (Mex.). Salary; wages. (Dwight)

Suelo (Mex.). Bottom; surface of ground. (Dwight)

Sugar of lead. Lead acetate.

Sugar spar (Corn.). Friable granular quartz. (Power)

Sugary quartz. A granular and somewhat friable and massive variety of quartz (Power). Sugar spar.

Suldenite. A name given by Stache and von John to gray, acidic, andesitic porphyrites in the eastern Alps. They range from 54 to 62 per cent, SiO_2, and have, in the prevailing gray groundmass, phenocrysts of hornblende, plagioclase, a little orthoclase, and accessory augite, biotite, and quartz. *Compare* Ortlerite. (Kemp)

Sulfato. 1. (Sp.) Sulphate. 2. (Mex.) In the *patio* process, sulphate of copper. (Halse)

Sulfuro (Sp.). 1. Sulphides; *Sulfuros* (Mex.), sulphide ores. 2. Rich sulphides of silver from lixiviation processes. (Halse)

Sullage. 1. Scoria on molten metal in the ladle. (Webster) 2. Water-deposited silt or mud. (Standard)

Sullage piece. Same as Deadhead, 1.

Sulman and Picard process. An oil flotation process in which are introduced bubbles of air or other gas, and also oil in the form of a spray, into the freely flowing acidulated pulp. (T. J. Hoover, p. 11)

Sulphate. 1. A salt or ester of sulphuric acid. 2. To treat or impregnate with sulphuric acid or a sulphate; to convert into sulphate. 3. To form a deposit of whitish scale (probably Pb_2SO_6, not the normal $PbSO_4$) on the plates of a storage battery. (Webster)

Sulphatite. A liquid compound found in certain volcanic regions, consisting of native dilute sulphuric acid, H_2SO_4. (Standard)

Sulphatize. To convert into sulphate, as by roasting sulphide ores. (Webster)

Sulphide. A binary compound of sulphur, or one so regarded. Formerly called Sulphuret. Excepting the sulphides of alkali and alkaline earth metals, the metallic suphides are insoluble in water, or nearly so, and many occur as minerals. (Webster)

Sulphide zone. That part of a lode or vein not yet oxidized by the air or surface water and containing sulphide minerals.

Sulphur. 1. A non-metallic element occurring naturally in large quantities either native or in various sulphides. Native sulphur occurs in yellow orthorhombic crystals, in masses, crusts, and powder. Symbol, S; atomic weight, 32.06; specific gravity, 2.06. (Webster)
2. Iron pyrite, occurring in coal seams (Steel). Also iron sulphide (pyrite) occurring with Wisconsin and Missouri zinc ore. In southern States, synonymous with Pyrite.
3. Sulphureted hydrogen, H_2S. Stink damp. 4. (So. Staff.) An old, but improper, term for fire damp. (Gresley)

Sulphur-burner. A blast furnace in which sulphur is burned in the manufacture of sulphuric acid. (Standard)

Sulphur-concrete. A mixture of sulphur with pulverized stoneware and glass, melted and run into molds. (Century)

Sulphuret (Pacific coast). In miners' phrase, the undecomposed metallic ores, usually sulphides. Chiefly applied to auriferous pyrites. Concentrate and sulphide are preferable (Raymond). An old synonym for Sulphide.

Sulphur group. The elements sulphur, selenium, tellurium, and oxygen: formerly classed together, owing to their many properties in common. (Standard)

Sulphuric acid. A heavy corrosive oily liquid, H_2SO_4, colorless when pure, early made by distilling green vitriol, hence the name oil of vitriol. Now made by the chamber process and the contact process. (Webster)

Sulphur ore. Pyrite, often roasted for its sulphur. (Webster)

Summer black-oil. A black lubricating oil of 540° F. fire test, used as a heavy tempering oil and for waterproofing cement. (Bacon)

Summer oil. A heavy, railway car and engine oil that has a flash-point of above 140° C. and solidifies below —5° C. (Bacon)

Sump. 1. (From the German *Sumpf.*) An excavation in the coal or rock made below the gangway or in the bottom of a shaft to collect mine water. The gangway ditches or drains empty into it, and the pump draws the water from it. (Chance)
2. (Newc.) That part of a judd of coal which is extracted first. (Raymond)
3. An excavation smaller than, and ahead of, the regular work in driving a tunnel or sinking a shaft.
4. A round stone-pit, lined with clay, for receiving the metal on its first fusion. (Webster)
5. A storage tank for solutions, usually at a level below other vats. (Clennell, p. 279)
6. To undercut coal preliminary to placing a short-wall machine in position for cutting along the working face. Sometimes called a Sumping cut.

Sumper. 1. (Eng.) A shot placed in or very near to the center of the bottom of a shaft. (Gresley)
2. (Scot.) A shot for breaking up the bottom or floor. (Barrowman)

Sump fuse. A waterproof fuse for use in a sump. (Standard)

Sumping. 1. (Scot.) Cutting down into the floor; or, in sinking, cutting down at the lowest part of the shaft. (Barrowman)
2. Forcing the cutter bar of a coal cutter into or under the coal. Also called Sumping cut. (C. and M. M. P.)
3. A small square shaft, generally made in the air headings, when crossing faults, etc., or made to prove the thickness of coal, etc. (Min. Jour.)

Sumping bar. An angle iron about 8 feet long with flanges about 4 inches high, weighing about 75 pounds. Its function is to guide the cutter bar on an electric coal cutting machine. (N. W. Rept., vol. 162, p. 861. Beck *v.* Beck Coal and Min. Co., Iowa)

Sumping cut. *See* Sump, 6.

Sumping hole (Aust.). The first or opening cut made by a coal cutter (Power). A sumping cut.

Sumping shot (Newc.). *See* Sumper, 1 and 2.

Sumpman (Corn.). A man employed in shaft sinking to assist the miner with the pumping machinery, timbers, etc.

Sump planks (So. Staff.). Strong timbers bolted together, forming a temporary bottom, or scaffolding, for the shaft. (Min. Jour.)

Sump pump. A pump employed to raise water from a mine sump. (Standard)

Sump shaft. That shaft in a mine at the bottom of which is the sump. (Standard)

Sump shot. A blast made near the center of a shaft that is being sunk, to make a collecting place for water. (Standard)

Sump solution. *See* Barren solution.

Sump winze. A winze sunk in the bottom of the lowest level, in order to explore the lode below and ascertain whether the sinking of the main shaft is advisable. (Standard)

Sun-baked. Hardened and desiccated by the sun's heat, as mud, clay, or unburnt bricks. (Standard)

Sun crack. *See* Shrinkage-crack.

Sunned oil. A trade name for crude petroleum, which is sometimes increased in density and fitted for use as a lubricant by exposing it to the sun as a thin layer on the surface of a tank of warm water, the more volatile portions being thus in part removed by evaporation. (Bacon)

Sun opal. Same as Fire opal. (Standard)

Sunshine. The trade name of a soft grade of paraffin wax with a low melting point. It can be burned in an ordinary miners' lamp with a nail (usually copper) in the wick and gives little smoke (Steel). *Also* Miners' sunshine.

Sunstone. A variety of oligoclase feldspar containing numerous small inclusions which cause a delicate play of colors. Used as a gem (U. S. Geol. Surv.).

Sun vein (No. of Eng.). Ore veins discovered on the south side of a hill. Sun is synonymous with south, so sun veins are south veins. (Power)

Superficial. *See* Surficial.

Superficial deposits. The most recent of geological formations; unconsolidated detrital material lying on or near the surface, generally unstratified. (Century)

Superficie (Sp.). Surface. (Dwight)

Superfluent. Applied by Dana to those igneous magmas which discharge at the summit of a volcano. *See* Effluent and Interfluent. (Daly, p. 131)

Supergene. Applied to ores or ore minerals that have been formed by generally descending water. Ores or minerals formed by downward enrichment (Ransome). *Compare* Hypogene, 2.

Superimpose. In geology, to establish a structural system over, independently of, and eventually upon underlying structures: said of terranes, rivers, drainage systems, valleys and other features of erosion; as, a *superimposed* valley. (Standard)

Superimposed drainage. A natural drainage system that has been established on underlying rocks independently of their structure. Three kinds are recognized: (*a*) by sedimentation, where the drainage system of newer strata is formed over and independently of that of closely underlying older strata; (*b*) by alluviation, where an extensive alluvial deposit has established a new and independent drainage system over that of the preceding surface; (*c*) by planation, where, after extensive planation of a rock-surface, a drainage system is established independent of the underlying rock-structure. (Standard)

Superphosphate. An acid phosphate; any fertilizing material consisting chiefly of soluble phosphates. (Webster)

Superposed. Not in adjustment to the structure of the rocks upon which it now flows, having acquired its course on a previously overlying terrane which has since been removed or cut through: said of some streams; same as superimposed, which it is replacing. (La Forge)

Superposición (Peru). Whole or part of a mining claim placed over an older one. (Halse)

Superposition. The order in which rocks are placed above one another. (Roy. Com.)

Superstratum. An overlying stratum or layer. (Webster)

Supplementary twining. Twining by which a crystal simulates the symmetry of a crystal class with higher grade in the same system. (A. F. Rogers)

Sur (Sp.). South. (Dwight)

Surbed. Set, as a stone, on edge, or in a position different from that in the quarry. (Standard)

Surcharge. 1. The algebraic sum of the losses and gains of a cornet of gold during cupellation and solution. (Ricketts, p. 128)
2. In ceramics, an enamel-painting on an enamel ground of darker hue. (Standard)

Surface. The top of the ground; the soil, clay, etc., on the top of strata (Barrowman). As used in the conveyance of coal in place, or in a conveyance of land reserving the minerals, includes not merely the surface within the boundary lines, without thickness, but includes whatever earth, soil, or land lies above and superincumbent upon the coal or mineral reserved. (Yander *v.* Right, 66 Indiana, p. 319; 32 American, p. 109; Stonegap Colliery Co. *v.* Hamilton, 89 S. E. Rept., p. 310)

Surface break; Surface damage. The disturbance or sinking of the strata reaching to the surface consequent on the extraction of coal or mineral. (Barrowman)

Surface charges. All expenses incurred on the surface of a mine which have to be charged against the mineral. (Duryee)

Surface condenser. A condenser in which exhaust steam is condensed by contact with the surfaces of metal cooled by a flow of cold water on their sides opposite the condensing surfaces. (Century)

Surface damage (Scot.). Ground occupied and damaged by colliery operations; the compensation for such. (Barrowman)

Surface deposits. Ore bodies that are exposed and can be mined from the surface. (C. and M. M. P.)

Surface geology. The geology of the superficial deposits and of the surface of the fundamental rocks. (Roy. Com.) *Compare* Aerial geology.

Surface glaze. In ceramics, a thin and perfectly transparent glaze over both the body and the decoration.

Surface lines. The boundary lines of a mining claim as indicated by the locator. (U. S. Min. Stat., p. 81)

Surface man. A miner (or other workman) employed in an open-air working. A yard or shop employee at a mine.

Surface mining. Mining at or near the surface; placer mining; open-pit mining. (Standard)

Surface rights. The ownership of the surface of land only, where mineral rights are reserved. (Weed)

Surface tension. That property, due to molecular forces, which exists in the surface film of all liquids and tends to bring the contained volume into a form having the least superficial area. The thickness of this film amounts to less than a thousandth of a millimeter, and is considered to equal the radius of the sphere of molecular action, that is, the greatest distance at which there is cohesion between two particles. Particles lying below this film, being equally acted on from all sides, are in equilibrium as to forces of cohesion, but those in the film are on the whole attracted inward, and tension results (Webster). As used in the flotation process, the contractile force at the surface of a liquid whereby resistance is offered to rupture. (Rickard)

Surface water. Water running into underground workings from the surface of the ground. (Barrowman)

Surface working. Same as Surface mining. (Standard)

Surfacing. 1. The top layer or crust of a pavement. 2. Treating the surface of a finished roadway with a bituminous material. (Bacon)
3. The act of placing the top of the rail on an even line. 4. Gold digging on the surface. 5. To wash the surface deposits for gold. (Webster) 6. The auriferous material that lies at the surface. (Standard)

Surfeit (No. of Eng.). Choke damp. (Gresley)

Surficial. Characteristic of, pertaining to, formed on, situated at, or occurring on the earth's surface; especially, consisting of unconsolidated residual, alluvial, or glacial deposits lying on the bedrock. (La Forge)

Surge tank. A standpipe or a storage reservoir at the down-stream end of a closed aqueduct or feeder pipe, as for a water wheel to prevent sudden variations of pressure and to furnish water quickly. (Webster)

Surging. The flapping of a moving rope, as of a hoisting cable. (C. M. P.). *See* Whipping, 1.

Surtidero (Sp.). A conduit or sluice; *S. de agua*, a reservoir; basin. (Halse)

Surturbrand. An Icelandic term for a peat-like variety of brown coal or lignite occurring in the Pliocene deposits, and sometimes under the volcanic overflows of that island. (Page)

Survey. 1. To determine and delineate the form, extent, position, etc. of a tract of land, coast, harbor or the like, by taking linear and angular measurements, and by applying the principles of geometry and trigonometry. 2. To view with a scrutinizing eye; to examine with reference to condition, situation, value, etc. (Webster).

Surveying. 1. Act or occupation of making surveys. 2. That branch of applied mathematics which teaches the art of determining the area of any portion of the earths' surface, the lengths and direction of bounding lines, the contour of the surface, etc., and accurately delineating the whole on paper. (Webster)

Surveyor. 1. One who surveys or measures land surfaces, mines, etc. 2. A customs officer. (Webster)

Surveyor general. 1. A principal surveyor. 2. An officer in charge of the survey of public lands of the United States. (Webster)

Surveyors' measure. A system of measures used by surveyors, of which the unit is the chain. (Standard)

Sussexite. A special name suggested by Brögger for the eleolite porphyry, originally described by Kemp, from Beemerville, Sussex Co., N. J. The name was, however, applied years ago to a hydrated borate of manganese and magnesia, from Franklin Furnace, N. J. (Kemp)

Sutton, Steele, and Steele dry table. A concentrator of the Wilfley type in motion, but instead of using water, stratification is by means of rising currents of air. The heavy grains are pushed forward by the head motion, while the lighter grains roll or flow down the slope toward the tailing side. (Liddell)

Suture joint. Same as Stylolite, *which see.*

Swab. 1. A kind of hemp brush for holding water to moisten mold joints, to spray on edges, to spread blacking on dry-sand molds, etc. 2. To clean, as with a swab; to mop. (Webster)

Swab stick. A stick frayed at one end, for cleaning the sludge out of holes in process of being bored for blasting. (Roy. Com.)

Swad (Newc.). A thin layer of stone or refuse coal at the bottom of the seam. (Raymond)

Swag. 1. (Lanc.) Subsidence or weighting of the roof. (Gresley) 2. (Aust.) A tramping bushman's luggage, rolled up in a long bundle and carried on the back or over the shoulder; any similar roll of luggage. (Webster)

Swage. A tool variously shaped or grooved on the ends or faces, used by workers in metals for shaping their work; a dolly, jumper, or upset (Webster). A tool used in sharpening drill bits.

Swage block. A perforated block of cast iron or steel, having grooved sides and adapted for use in heading bolts and swaging large objects. (Webster)

Swaged. Reduced in diameter by use of blacksmith's swages, hence the name. This is a hammering process, but the same result may be attained by press forging or spinning. (Nat. Tube Co.)

Swagman (Aust.). A man who travels in search of employment; so called because he carries his swag, or bundle of clothes, blankets, etc. (Century)

Swallet (Eng.). 1. A fissure or hole; especially a fissure in limestone rocks through which a stream sinks (Webster). *Also* Swallow; Swallows.
2. An inrush of water in a mine.

Swallow (Derb.). A loose, broken, or porous place in a vein. It derives its name from the ease with which water sinks through the loose material (Hooson). *Also* Swallet.

Swallow hole. *See* Sink, 1; Sink hole.

Swally; Swelly. A trough, or syncline, in a coal seam. (C. and M. M. P.)

Swamp. 1. A local depression in a coal bed in which the water collects. Applied particularly in bituminous coal mining. (Chance)
2. As applied to a mining claim, to clear a narrow strip along the boundary line, where the location is on timber land. (Leveridge *v.* Hennessey, 135 Pac. Rept., p. 909)

Swamper. A rear brakeman in a metal mine.

Swamp marl. A marl, found at the outlets of lakes, composed of myriads of tiny shells in different stages of cementation. (Standard)

Swamp muck. Imperfect peat, especially the less compact variety. (Century)

Swamp ore. Bog iron ore; Limonite. (Webster)

Swape (No. of Eng.). A large oar by which coal boats are steered (Gresley). A variation of Sweep.

Swarf. 1. (Scot.) A tool for widening bore holes. (Barrowman)
2. Fine metallic particles removed by a cutting tool; chippings from soft iron castings, used as a reducing agent in certain chemical manufactures. (Webster)

Swaugh (Derb.). A soft clay in the vein. (Hooson)

Swaying of a bank (York.). Undergoing disturbance due to weight of the roof. A settling of the mine roof. (Gresley)

Sweal. 1. (Eng.) To burn slowly. 2. To melt and run down; to waste away without feeding the flame. A candle is said to sweal when the grease runs down, owing to its burning in a strong current of air or being improperly carried or fixed. (Gresley)

Sweat. 1. To condense moisture in beads or drops on the surface (Webster). The roof of a mine is said to sweat when drops of water are formed upon it, by condensation of steam formed by the heating of the waste or goaf. (Gresley)
2. To exude nitroglycerin; said of dynamite. (Webster)

Sweating. The condensation of moisture and distillation products on the surface of a roast heap, forming a damp and sticky crust. (Peters, p. 120)

Swedge; Drift. A tool used in oil wells for straightening bulged casing. (Mitzakis)

Swedish iron. A soft and comparatively pure iron. (C. M. P.)

Swedish process. *See* German process.

Sweep. 1. A curved metal blade projecting from the central shaft of a pug mill, to force clay through holes at the bottom. 2. In founding, a profile pattern, used especially in forming molds for cylindrical or other symmetrical articles. (Standard)
3. (Aust.) That part of a branch that reunites with the main vein farther on. (Power)

Sweeper. 1. One who cleans the brick pavement between stock house, stoves, and blast furnace. (Willcox)
2. In an iron mill, one whose duty it is to remove with a twig broom the scale that forms on plates, etc., during the process of rolling. (Standard)

Sweep-head pick (Eng.). A curved pick. (Gresley)

Sweeping. *See* Sweeps, 1.

Sweeping table. A stationary buddle. (Raymond)

Sweep-plates (Eng.). Curved plates for barrow ways at a turn. (Bainbridge) A turn sheet.

Sweep-point (Aust.). The curved rail of a turnout that crosses the main rails and is moved against or from the outer main rail, according to the track it is desired the skip or car shall run on. (Power)

Sweep rail (Aust.). The inner curve of a turnout. (Power)

Sweeps. 1. The dust of the workshops of jewelers, goldsmiths, silversmiths, and assayers and refiners of gold and silver (Raymond). Also Sweeping.
2. (Eng.) Brushes or pieces of cloth for sweeping the smooth surface of a buddle. (Hunt)

Sweepwasher. A person who extracts precious metals from the sweepings of refineries of gold and silver. (Ure)

Sweepwashings. Valuable metal washed from sweepings. (Standard)

Sweet (Eng.). Free from fire damp or other gases, or from fire stink. (Gresley)

Sweetish astringent. Applied to those minerals that have the taste of alum. (Dana)

Sweet roasting. Complete roasting, or until arsenic and sulphur fumes cease to form. *See* Roasting.

Swell. 1. A local enlargement or thickening of an ore or coal deposit. (Webster)
2. A space in a seam from which the coal has been eroded and its place filled with clay or sand. Called also Horse, Horseback, Swineback, Want. (Standard)
3. A low dome or quaquaversal anticline of considerable areal extent. (La Forge)

Swelly (No. of Eng.) A local thickening of a coal seam. Also called Swally; Swilley; Swell. (Standard)

Swilling-vat. A vat in which tinplate is washed after pickling. (Standard)

Swilly (York.). A detached portion of coal strata. (Gresley) *See* Swell, 2.

Swimming stone. A variety of opal that floats on water: found in light, spongy, concretionary or tuberose masses. Called also Floatstone. (Standard)

Swindell producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 315)

Swine back (Wales). *See* Horseback, 3 and 5; also Swell, 2.

Swine stone. A variety of marble that gives off a fetid odor when broken or rubbed (Power). Also called Stink Stone. *See* Bituminous limestone.

Swing (Eng.). The arc or curve described by the point of a pick or maundril when being used. Also called the swing of the pick. (Gresley)

Swinging a claim. The adjustment of the boundaries of a mining claim to more nearly conform to the strike of the vein. A reasonable time is allowed the discoverer to explore the vein or lode to find out its strike and thus enable him to lay his claim. (U. S. Min. Stat., p. 233)

Swinging bont; Swinging bant (Mid.). Before the introduction of cages and guides, the skips or buckets of coal, etc., also the men, were raised and lowered swinging loose in the shafts (Gresley). *See* Bant.

Swinging plate. An amalgamated copper plate hung in a sluice to catch float gold. (C. and M. M. P.)

Swing jack. A jack used to replace derailed cars on a railway track. (Century)

Swing loose (Ark.). To gradually loosen over a considerable area and sag. Said of the rock over a mine working. (Steel)

Swing parting (Ark.). A parting some distance from the mouth of an entry. The loaded cars are left by the gathering driver to be taken out by a swing driver, with a swing mule or a spike team. (Steel)

Swing table. A movable bed on which plate glass is cemented for polishing; a runner. (Standard)

Switch. 1. The movable tongue or rail by which a train is diverted from one track to another. 2. The junction of two tracks. 3. A movable arm for changing the course of an electrical current. (Steel)

Switchback. An arrangement of zigzag railroad tracks for lessening the grade up a steep hill (Webster). Common in mountainous mining districts.

Switchboard. A board where several electrical wires terminate and where by means of switches connection may be established between any of these wires and the main wire. (C. and M. M. P.)

Switch plate. An iron plate on tramroads in mines, to change the direction of movement of cars (Standard). A turn sheet.

Switch rope. A short length of rope fitted with a hook on one end and a link on the other, used for the switching of cars. (C. M. P.)

Swither. A term used in Wisconsin lead regions to denote a crevice or crack branching from a main lode. (Power)

Swivel. In oil-well drilling, a short piece of casing having one end belled over a heavy ring, and having a large hole through both walls, the other end being threaded.

Swom stuff (Eng.). An old term for certain alluvial deposits found in coal measures. (Gresley)

Sycee-silver. Pure, uncoined, lump silver of various sizes, usually having a banker's or assayer's seal stamped on them, used by Chinese as a medium of exchange and reckoned by weight. The larger, sometimes called Shoes, are boat-shaped, and weigh about one pound troy. (Standard)

Sycite. A fig-shaped pebble or mass of flint. (Standard)

Syderolite. A variety of Bohemian earthenware. (Standard)

Syenite. Any granular igneous rock composed essentially of orthoclase, with or without microcline, albite, hornblende, biotite, augite, or corundum. (La Forge) In mica syenites hornblende is replaced by biotite and in augite syenites it is replaced by augite. If a small quantity of quartz is present it is called quartz syenite. In nepheline syenite the feldspar is partly replaced by nepheline. (U. S. Geol. Surv.)

Syenite porphyry. A rock of porphyritic texture and same mineral composition as syenite (Ries)

Sylvan. Native tellurium. (Standard)

Sylvanite. A gold-silver telluride, $(Au,Ag)Te_2$, containing gold and silver in the atomic ratio of 1 to 1. This requires 24.5 per cent of gold and 13.4 per cent silver. (U. S. Geol. Surv.)

Sylvite. Native potassium chloride, KCl. (Dana)

Symbols of crystal faces. In crystallography, the mathematical expressions for designating the position of crystal faces on coordinate axes. (A. F. Rogers)

Symmetrical dispersion. In optical mineralogy, the dispersion which produces an interference figure with color distribution symmetrical to the trace of the axial plane and also to a line normal to it. (A. F. Rogers)

Symmetry. The regular and symmetrical arrangement of certain properties of crystalline substances, such as their crystal form, their optical properties, and their electrical properties, with reference to certain fundamental planes and axes, called planes and axes of symmetry. It depends upon and is a consequence of the molecular structure of the crystal. (La Forge)

Symon fault. Same as Swell, 2.

Symon's disk crusher. A mill in which the crushing is done between two cup-shaped plates that revolve on shafts set at a small angle to each other. These disks revolve with the same speed in the same direction and are so set as to be widest apart at the bottom. Feed is from the center, and the material is gradually crushed as it nears the edge, and is then thrown out by centrifugal force. (Liddell)

Synchronal. Occurring at the same time. (Power)

Synchroneity. Synchonism; specifically (*Geol.*), supposed coincidence in the time of formation; said of strata. (Standard)

Synclase. A term used by Daubrée for minor divisional planes produced by some intense mechanical or molecular motion; generally by contraction, as in cooling and drying. (Power)

Synclinal. In geology, characteristic of, pertaining to, occurring, or situated in, or forming a syncline. (La Forge) The opposite of anticlinal.

Synclinal axis. In geology, the central line of a syncline, toward which the beds dip from both sides. (La Forge)

Syncline. A fold in rocks in which the strata dip inward from both sides toward the axis. The opposite of Anticline. (La Forge)

Synclinore. Same as Synclinorium.

Synclinorium. A compound syncline: a closely folded belt the broad general structure of which is synclinal. (La Forge) Called also Synclinore.

Syndicate. An association or group of persons, usually financiers or capitalists, who combine to carry out, on their own account, a financial or industrial project, as the underwriting of an issue of bonds, the carrying out of a great industrial enterprise, etc. (Webster)

Syngenetic. In mineralogy, formed at the same time as the inclosing country rock: said of some ore deposits. (La Forge)

Synthesis. In chemistry, the act or process of making or building up a compound by the union of simpler compounds or of its elements. Contrasted with analysis. (Webster)

Syssiderite. Daubrée's name for those meteorites that consist of silicates cemented together by metallic iron. (Kemp)

System. 1. A great series of strata having some general character in common. Formations are local divisions and many of them can only be recognized in one country, whereas systems are sufficiently comprehensive to be recognized in all parts of the world (Roy. Com.). The stratigraphic division of second rank, in the nomenclature in general use. The chronologic division of equivalent rank is a *period.*
2. In crystallography, the division of first rank, in the classification of crystals according to form. The six systems ordinarily recognized are the Isometric, Tetragonal, Hexagonal, Orthorhombic (or rhombic), Monoclinic, and Triclinic; some divide the hexagonal system into Hexagonal and trigonal. (La Forge)
3. Regluar method or order; plan.

Systematic timbering. Placing mine timbers according to a predetermined plan, regardless of roof conditions. (C. and M. M. P.)

T.

Tabah (Sumatra). A crowbar used in gold mining. (Lock)

Tabby (Morocco). A mixture of lime with shells, gravel, or stones in equal proportions, with an equal proportion of water, forming a mass which when dry becomes as hard as rock; a substitute for bricks or stone in building. (Century)

Tabbyite. Same as Wurtzilite.

Tabique. 1. (Mex.) A partition wall in a mine. (Dwight)
2. (Chile) A small square inclosed by walls about 4 feet high for roasting silver-bearing galena. (Halse)

Tabla (Mex.). 1. Board or plank. 2. The broader face of a beam or timber. 3. One of the sides or front of an excavation. 4. *T. de alto,* hanging wall; *T. de bajo,* foot wall. (Dwight)

Tabladillo (Peru). An inverted *injenio* in which the horizontal water wheel is arranged above the mill stones. (Pfordte)

Table. 1. (Scot.) A platform or plate on which coal is screened and picked. (Barrowman)
2. A concentrating machine for separating finely crushed particles of ore from gangue. (Weed)
3. The upper flat surface of a diamond or precious stone, the sides of which are cut in angles; a large flat facet on the top of a brilliant.
4. A circular plate of crown glass. (Webster)
5. An iron slab with a raised rim, on which melted glass is spread in making plate glass. (Standard)

Table cut. Having a flat top or table with a beveled or triangular facet border; said of cut diamonds, emeralds, etc. (Standard)

Table cutter. A lapidary who cuts tables or plane faces on diamonds or other precious stones. (Century)

Table diamond. A thin diamond cut with a table, 3, faceted on beveled sides or edges, and a flat undersurface. (Webster)

Tableland. A plateau, or elevated region of flat or undulating country rising to heights of 1,000 feet and more above the level of the sea (Power). *See* Plateau.

Tableman. In a plate-rolling mill, one who works at a table. (Standard)

Table mountain. A mountain with a flat top. (Standard)

Tablero (Mex.). A tally board. (Dwight)

Table spar. Tabular spar. *See* Wollastonite. (Century)

Tabletura (Sp.). A slab. (Lucas)

Tablón (Mex.). A wooden plank. (Dwight)

Taboleiros (Braz.). Lower bench deposits or placers older than the present river channels. (Halse)

Tabréez marble. A beautiful transparent limestone, composed of innumerable laminæ, thin as paper, and formed by deposition from a celebrated calcareous spring near Maragha, Persia. (Page)

Tabular crystal. A crystal flattened parallel to any face. (Standard)

Tabular spar. Wollastonite. (Standard)

Tabular structure. A tendency in certain igneous or crystalline rocks to separate into plates or laminæ. (Standard)

Tachia (Bol.). Llama dung (Lucas). *Also* Taquia.

Tachylyte. Basaltic glass; hyalomelane; the glassy rock forming the thin peripheral shell of some basalt masses. (La Forge)

Tack. 1. (No. of Eng.) A small pillar. *See* Spurn. 2. (Som.) A wooden scaffold put into a mine shaft for temporary purposes. (Gresley)
3. A small pillar of coal. (Morine)
4. Veinstone; Gangue, etc. (Duryee)
5. (Scot.) A mining lease. (Barrowman)

Tackle (Corn.). The windlass, rope, and kibble. (Raymond)
An assemblage of ropes and pulleys arranged for hoisting or pulling. (Webster)

Tackler skip (So. Staff.). A kind of box in which men used to ride in a shaft; used also for carrying minerals. *See* Paddy pan; Bant, 2, and Bont, 1. (Gresley)

Tacklers; Tucklers (Leic.). 1. Small chains put around the top of loaded tubs or buckets, to keep the coal from falling off. 2. Short chains formerly used for raising and lowering men in a shaft. Three men generally sit in them at one time. *See* Bant, *also* Bont, 1. (Gresley)

Tacksman (Scot.). The lessee of a colliery (Gresley). *See* Tack, 5.

Taco (Sp.). 1. A stopper or plug. 2. Tamping or stemming. 3. A tamping bar or rammer. 4. *Tacos* (Mex.) Stones in the bottom of an *arrastre*. (Halse)

Taconic. That series of rocks containing the primordial fauna, at least that portion which is older than New York Potsdam. It is the Lower Cambrian of English geologists, and the Huronian of the typical Huronian area of the Canadian geologists. Named from the Taconic mountains of western New England, by Dr. E. Emmons, it antedates, as a primordial system, both Cambrian and Huronian. It is the principal iron-ore-bearing system of the Lake Superior region. (Winchell) The term was not generally accepted by geologists.

Taconite. *See* Taconyte. Also called Jasper, and Iron formation.

Taconyte. A name proposed by H. V. Winchell for the cherty or jaspery, but at times calcareous or more or less quartzitic rock, that incloses the soft hematites of the Mesabi Range, Minn. Taconytes are regarded as in large part altered greensands by J. E. Spurr. The term is current in the Mesabi iron range. The name is derived from Taconic, E. Emmons' rejected geological system. (Kemp)

Tactite. A rock of more or less complex mineralogy formed by the contact metamorphism of limestone, dolomite or other calcareous rocks into which foreign matter from the intruding magma has been introduced by hot solutions. It does not include the inclosing zone of tremolite, wollastonite and calcite. A group name similar to gneiss, schist or porphyry. (Frank L. Hess)

Tag. A numbered piece of tin or wood that a miner attaches to, or places on, the cars loaded by him. These tags are removed at the tipple where the car is credited to the miner. *See* Ticket, 3. *Compare* Wedge rock.

Tagger. Tin plate below the standard size; or in the plural, very thin tin plate. (Standard)

Tague (Eng.). An iron plate fitted on one side with a semicircular projection or rib, and two other short curved pieces, adjusted to the gauge of the tram rails, by which the wheels of the trams are guided from the plate onto the rails. (Gresley)

Tahona (Mex.). An arrastre operated by water power (Dwight). In Western U. S., an arrastre operated by horse- or mule-power. (Standard)

Tahonero (Mex.). The man in charge of the *tahona*. (Dwight)

Tail. 1. (Also plural). The inferior, less valuable, or refuse part of anything; foots, bottoms, dregs; sediment. *See* Tailings. (Murray)
2. The poor grade of ore slime at the lower end of the slime-box as it flows from the stamps. 3. The unexposed end of a brick or stone in a wall; a tailing. (Standard)

Tail-back (Eng.). When fire damp ignites and the flame is elongated or creeps backward against the current of air, and possibly causes an explosion of a large body of gas, it is said to tail-back into the workings. (Gresley)

Tail chain (Scot.). A chain by which a horse hauls hutches or wagons. Putters in former times also used a tailchain. (Barrowman)

Tail-crab. In mining, a crab or winch for operating a tail-rope. (Standard)

Tail house; Tail mill. The buildings in which tailings are treated. (Raymond)

Tail-in (Mid.). To run out or terminate a length of holing stints at a buttock or other point along the stall face. (Gresley)

Tailing. The refuse from a metallurgical process; if the refuse from several processes or more than one mill should meet, the result could be described as "tailings" (Rickard). The material from which one of more concentrated or partly concentrated products have been removed, and which is available for further treatment. (Eng. and Min. Jour., vol. 107, p. 317) Usually used in the plural. *See* Tailings.

Tailing machine (Aust.). A machine or apparatus for dressing the tailings, and for obtaining gold from the detritus from other ore dressing apparatus. (Davies)

Tailing out. *See* Dying out.

Tailing-pit. *See* Catch-pit.

Tailings. 1. The parts, or a part, of any incoherent or fluid material separated as refuse, or separately treated as inferior in quality or value; leavings; remainders; dregs. In metallurgy, the part rejected in washing an ore that has passed through the screens of a stamp-mill; the worthless slimes left after the valuable portion has been separated by dressing or concentration. The sand, gravel and cobbles which pass through the sluices in hydraulic mining were formerly generally designated as tailings, but of late years, especially in State and United States legislative documents, they have been called "mining débris" or simply "débris". (Century)
The lighter or refuse ore accumulated at the lower end of a buddle, or washing apparatus, or carried away by the water. (Webster)
Those portions of washed ore that are regarded as too poor to be treated further: used especially of the débris from stamp mills or other ore-dressing machinery, as distinguished from material (concentrates) that is to be smelted. (Standard)
The inferior leavings or residue of any product; foots, bottoms. In mining the residuum after most of the valuable ore has been extracted. (Murray's Dict.)
The term "tailings" has been construed as including slag. (Butte & Boston Cons. Min. Co. *v.* Montana Ore Purchasing Co., 121 Fed. Rept., p. 526)
The term "tailings" as used in the mineral industry is used in the plural form by all of the authorities cited above.
2. The decomposed outcrop of a vein or bed. (Murray's Dict.)

Tailings wheel. A wheel carrying buckets or compartments on the periphery and used in conveying liquid, pulp, or sand from a lower to a higher level. (Clennell, p. 181)

Tailles chansantes (Fr.). Coal workings where the strata lie horizontal or nearly so. (Gresley)

Tailles montantes (Fr.). Workings to the rise in steep seams. (Gresley)

Tail of level (Scot.). The delivery end of a water level. (Barrowman)

Tail of water (Scot.). The edge of standing water in workings. (Barrowman)

Tail pipe. The suction pipe of a pump.

Tailrace. The channel in which tailings, suspended in water, are conducted away. (Raymond)

Tail rope. 1. The rope that is used to draw the empties back into a mine in a tail-rope haulage system.
2. A counter-balance rope attached beneath the cage when the cages are hoisted in balance. (C. M. P.)
3. A hemp rope used for moving pumps in shafts. (Gresley)

Tail-rope haulage. A system of rope haulage by which the full hutches (cars), with the tail rope attached behind, are drawn by a main rope passing over a drum, and the empty hutches, with the main rope attached, are drawn back again by the tail rope passing over another drum. (Barrowman)

Tails (Corn.). Refuse tin ore thrown behind the stamps to be treated again (Davies). *See* Tailings.

Tails-common (Eng.). Washed lead ore.

Tail sheave (Aust.). The return sheave for an endless rope or the tail rope of the main-and-tail-rope system, placed at the far end of a haulageway. (Power)

Tail water. Water in a tail race.

Tajadera. 1. (Mex.). A wedge to break the slimes deposited in the vat of the *patio* process. (Halse)
2. A chopping knife; a chisel.
3. A sluice from a mill dam. (Vel.)

Tajear (Peru). To stope, usually underhand. (Halse)

Tajo (Sp.). 1. A cut or opening in a mountain. 2. *T. abierto* (Mex.), open-cut mining. 3. A working place or cut. Any long, vide opening, as distinguished from a gallery or shaft. (Halse)

Take. 1. (Eng.) The extent or area of a lease of mineral property, often several thousand acres. 2. (Lanc.) To show or reveal gas. (Gresley)

Taker (Eng.). A contractor; a man who works in a mine on tribute. (Davies)

Taking (Eng.). A mineral-land lease. *See* Take, 1; *also* Tack. (Gresley)

Take out (Cumb.). To crop out (Gresley). An out-crop.

Take over. To assume the ownership, control, or management of, as a mining property.

Taker-off (York.). Same as Puller-off

Take the air. 1. To measure the ventilating current. 2. Applied to a ventilating fan as working well, or working poorly. (Steel)

Take-up-bottom (Ark.). To remove rock from the floor of a roadway to increase the height; also called Bottom brushing. (Steel)

Taker (Corn.). A leaser; a contract miner. (Pryce)

Taking-off boy. In brickmaking, a boy who removes newly made bricks from a pallet or brick-machine to the barrow. (Standard)

Taking-of-props (Lanc.). Drawing the timbers from the mined-out workings. (Gresley)

Talabordón (Colom.). A board or plank to increase the height of a dam, flume, etc. (Lucas)

Talacha (Mex.). A mattock; a pick-ax. (Halse)

Taladrar (Sp.). To bore or drill. (Dwight)

Taladro (Mex.). 1. A drill; rock drill. *T. de punta de diamante*, a diamond drill. 2. A boring bit. 3. The hole bored by a drill. 4. (Cent. Am.) An adit or level. *See* Socavón. (Halse)

Talc. A hydrous magnesium silicate, $H_2O.3MgO.4SiO_2$. Has a greasy or soapy feel and is soft and easily cut. Occurs in beds more or less impure and is then known as steatite or soapstone. Also called Potstone because it has been used for pots, owing to the ease with which it is worked and to its resistance to ordinary heats. French chalk is a variety used for crayons. *See* Soapstone. (U. S. Geol. Surv.)

Talcite. 1. A massive variety of talc. 2. A kind of muscovite. (Century)

Talco (Sp.). Talc. (Min. Jour.)

Talcoid. Resembling talc, as talcoid schist. *See* Sericite. (Roy. Com.)

Talcose. Containing talc, as potstone, steatite, and talcose schist. (Roy. Com.)

Talcose granite. Same as Protogine. (Standard)

Talcose schist. Same as Talc-schist. (Standard)

Talc-schist. Schistose rocks consisting chiefly of talc and quartz. Talc is also prefixed to several other rock names. (Kemp)

Talcum. Talc; Soapstone.

Tale (Som.). A day's work or a day's output of coal. (Gresley)

Talega (Mex.). Coin bag. (Dwight)

Talio (Sp.). Thallium. (Dwight)

Talk. An old form of the word talc.

Tallar (Sp.). To cut gems; to hew stones. (Halse)

Taller (Sp.). 1. A shop. 2. A laboratory. 3. A mill; *T. de preparación mecánica*, ore dressing floors. (Halse)

Tallow drop. A style of cutting precious stones in which the stone is domed on one or both sides. (Century)

Tallow top. A precious stone with a very rounding front and a flat back. (Standard)

Tally. 1. A mark or number placed by the miner on every car of coal sent out of his place, usually a tin ticket. By counting these, a tally is made of all the cars of coal he sends out. Called a Check in Arkansas. *See* Tag; *also* Ticket and Motty, 2. 2. Any numbering, or counting, or memorandum, as a tally sheet. (Steel)

Tally-shouter (Eng.). One who calls out the numbers on the tallies to the weigher. (Gresley)

Talmi-gold. A kind of brass made to resemble gold, sometimes plated. Called also Abyssinian gold. (Standard)

Ta-lou (China). A glass-flux consisting of lead silicate with a little copper, used by the Chinese as an enamel-color on porcelain. (Standard)

Talud (Sp.). Slope or declivity of a bank; talus. (Halse)

Talus. A heap of coarse rock-waste at the foot of a cliff, or a sheet of waste covering a slope below a cliff; same as Scree, which is more commonly used in Great Britain, whereas talus is more commonly used in the United States, but is often incorrectly used for the material composing the talus. (La Forge)

Tambang (Sumatra). Mines. (Lock)

Tambikir quali (Malay). A black incrustation found on auriferous quartz. (Lock)

Tambor (Sp.). 1. Hoisting drum. 2. A trommel. 3. *Veta de T.*, a bunchy vein. 4. (Colom.) A vertical shaft between two levels; a winze. (Halse)

Tambre (Colom.). A dam. (Halse)

Tamiz (Mex.). Fine screen. (Dwight)

Tamizar (Peru). To sift or screen. (Halse)

Tam-o-Shanter. A very fine-grained soft, gritty, natural stone found in Scotland. It is used in the United States as an ax stone and for sharpening knives. (Pike)

Tamp. To fill (usually with clay) the bore hole or other opening through which an explosive charge has been introduced for blasting. (Raymond)

Tamper. 1. One who tamps. 2. An implement for tamping; a tamping iron or tamping bar (Standard). Sometimes made of wood, copper, or iron with a copper tip. *See* Tamping bar.

Tamping. In common mining parlance the word *tamping* is now, and for a long time has been used, to designate both the inert material used on top of a charge of powder or dynamite, and the operation of compressing it into place. *See* Stemming, which is the term preferred for the inert material, while tamping more correctly is the act of compressing the stemming.

Tamping bar. An iron bar, shod with copper to obviate striking fire, used for compressing the stemming. *See* Tamper.

Tamping plug. A plug of iron or wood used instead of tamping material (stemming) to close up a loaded blast hole. (Standard)

Tanate (Mex.). Leather, hide or jute bag to carry ore or waste rock. (Dwight)

Tanatero (Mex.). A laborer, or bag carrier. (Dwight)

Tanda (Mex.). The ore or waste (usually waste) that is knocked down or loosened in driving a face or sinking a shaft. (Dwight)

Tangers (Wales). Timbers fixed in a particular manner for supporting the sides of headings in soft ground. (Gresley)

Tank. 1. A large vessel or receptacle, made either of wood or of metal, intended to contain a fluid as gas or water; as water tank, gasoline tank (Rickard). Used as a synonym for Vat.

2. A subterranean reservoir into which a pump delivers water for another pump to raise. (Raymond)

Tankage. 1. The act or process of storing oil, etc., in a tank. 2. The price charged or paid for storage in a tank. 3. The capacity of a tank or tanks. 4. The waste residue deposited in lixiviating vats or tanks. (Century)

Tank furnace. A glass-making furnace having a tank instead of the usual pots. (Standard)

Tanque (Mex.). Tank or cistern; *T. de asiento*, a settling tank. (Halse)

Tantalic ocher. A native brown tantalum oxide found in Finland. (Standard)

Tantalite. The member of the tantalite-columbite group of minerals which is composed of nearly or quite pure tantalate of iron and manganese. Nearly all tantalite contains some columbium. The members of the group containing more columbium are known as columbite. Tantalite is very rare. Pure tantalite, $(Fe,Mn)Ta_2O_6$, would contain about 86 per cent Ta_2O_5, or 70.4 per cent tantalum, but the percentage in actual minerals is generally much lower. (U. S. Geol. Surv.)

Tantalum. A metallic element found in various rare minerals. It is isolated as a rather brittle lustrous white metal, with a slightly grayish tint. Symbol, Ta; atomic weight, 181.5; specific gravity, 14.49. (Webster)

Tap. 1. To cut or bore into old workings for the purpose of liberating accumulations of gas or water. 2. To win coal in a new district. (Gresley)
3. The quantity of metal run out from a furnace or cupola at any one time. 4. A tool for forming an internal screw, as in a nut. 5. A small valve. (Webster)

Tapa (Sp.). 1. Cover. 2. Roof or hanging wall. 3. A sort of cofferdam used in placer mining. (Halse)

Tapanhoacanga (Braz.). A gold-bearing gravel composed of the disintegrated and weathered remains of specular iron ore. (Halse)

Tapajos (Sp.). Bandages to cover the eyes of the mules when treading in the *patio* process, or when being loaded or unloaded . (Halse)

Tapar (Mex.). To stop a furnace-tap with clay. (Dwight)

Tapatinga (Braz.). A variegated clay in the Amazon valley. (Halse)

Tap bar. A pointed bar by which a blast furnace tap hole is opened or the metal in a melting pot, etc., is tested. (Standard)

Tap cinder. The cinder drawn from a puddling furnace or bloomery. (Raymond)

Tape. A long, thin, narrow band of mineral or ore. (Standard)

Taper off (Corn.) To stop work temporarily. (Weed)

Taper rope. A rope that has a gradually diminishing diameter from the upper to the lower end. The diameter of the rope is decreased by dropping one wire at a time at regular intervals. Both round and flat ropes may be made tapered, and such ropes are intended for deep-shaft hoisting with a view to proportioning the diameter of the rope to the load to be sustained at different depths. (C. M. P.)

Tapestle (Mex.). 1. A working platform or stage built up in a stope, or anywhere in a mine. 2. A landing place between two flights of ladders. (Dwight)
3. (Colom.) Pillars of ore left to support the wall. (Lucas)

Tapestry brick. Brick made by the stiff-mud process and having all surfaces roughened by wire cutting. Much used now for exteriors. (Ries)

Tap hole. 1. The opening through which the molten metal is tapped or drawn from a furnace. (Winchell)
2. In steel manufacturing, a hole in a cementation furnace for the withdrawal of trial bars for testing. (Webster)
3. In a puddling furnace, a hole for drawing off slag (Standard). Called also Tapping hole.

Tapia (Sp.). A building material made chiefly of clay or earth; sometimes mixed with lime and called Tapia real. (Webster)
2. A mud wall. (Halse)

Tapiador (Sp.). A builder of mud walls. (Halse)

Tapish. 1. (Eng.) To break in "at unawares," as gas. A miner who just escapes with his life is said to be "tapished." (Hunt)
2. (Derb.) To let water out of a mine by tapping the place where the water is confined. (Mander)

Tapón. 1. (Sp.) A plug; a stopper. 2. (Mex.) A penthouse. 3. (Colom.) A kind of dike or dam used in placer mining. (Halse)

Taponear (Colom.). To construct a dike or cofferdam. (Halse)

Taponera (Mex.). A dolly bar. (Dwight)

Tappet; Disc. The collar under which the cam is inserted so as to lift the stamp. (Raymond)

Tapping bar. *See* Tap bar.

Tapping clay. A plastic clay used in plugging the tap hole of a smelting furnace. (Standard)

Tapping the hollows (Eng.). Allowing water or gas, or both, to flow out of old or abandoned workings, often under a great pressure. (Gresley) *See* Tappish.

Taqueador (Colom.). 1. One who fires a blast; a blaster. 2. A tamping bar. (Halse)

Taquia (Peru). Llama dung, used for fuel in roasting and smelting. (Dwight). *Also* Tachia.

Tar. 1. A thick, brown to black, viscous liquid obtained by the distillation of wood, coal, peat, and other organic materials, and having a varied composition according to the

temperature and material employed in obtaining it. (Webster)
2. Soft pitch or thickened petroleum, found in cavities of some limestones. (Roy. Com.)

Tara (Mex.). Tare weight. (Dwight)

Tar distillate. The paraffin distillate, or distillate containing the paraffin wax. (Bacon)

Tarea. 1. (Mex.) Task; job. It is common in Mexico to engage common laborers by the *tarea*. (Dwight) 2. (Cent. Am.) The duty or capacity of stamps in crushing. 3. (Santo Domingo) A land area equal to 0.1565 acre. (Halse)

Target. The vane, or sliding sight, on a leveling rod. (Webster)

Target rod. A level rod. (Webster)

Tarn (Iceland). A bog; fen; marsh or pool. (Humble)

Tarnish. 1. In mineralogy, the thin film of color, different from that of a fracture, that forms on the exposed surface of a mineral, especially a metallic mineral, as columbite. (Standard)
2. A change of color resulting from exposure to atmospheric action. (George)

Tarnowitz process. A metallurgical process in which large charges of lead ore are roasted at low temperatures in furnaces and treated substantially as in the Carinthian process. The residual containing considerable lead is remelted in special furnaces. *See* Silesian method. (Goesel)

Tarrango (Mex.). A platform in stope or shaft. (Dwight)

Tar water. A tarry, ammoniacal water obtained in the process of cleansing illuminating gas in a condenser. (Standard)

Tar well. A receptacle in which is collected the tarry liquid which separates from the gas when it leaves the condensers. (Century)

Tasco. A fire clay from which melting pots are made. Spelled also Tasko. (Standard)

Tases (Mex.). Masses of ore that have been calcined in the open air or in heaps. (Halse)

Tasmanite. A reddish brown, resinous mineral, disseminated in scales through a laminated shale (combustible shale) from the river Mersey, Tasmania; it has a specific gravity of 1.18 and yields oil on distillation (Bacon). Called also Resiniferous shale.

Tassette (Fr.). A small, sharp-pointed infusible earthenware cone, used in threes to support plates, etc., in a kiln or muffle, in place of a stilt or triangle. (Standard)

Tatham furnace. A stationary crucible furnace for retorting zinc crusts. (Hofman, p. 486)

Tatús (Braz.). Labyrinth-like mine workings. (Halse)

Taurite. A name given by A. Lagorio to a variety of rhyolite, with granophyric or spherulitic texture, rich in soda, and containing aegirite. (Kemp)

Tawite. A granular igneous rock composed essentially of sodalite and pyroxene. (La Forge)

Taxite. Loewinson-Lessing's name for lavas that, on crystallizing, have broken up into contrasted aggregates of minerals so as to present an apparent clastic texture—either banded, *i. e.*, eutaxitic, or brecciated, *i. e.*, ataxitic. (Kemp)

Taxitic. Having separated, during cooling, into small portions differing in texture, color, or composition, and hence having a false appearance of being clastic: said of some volcanic rocks, especially if banded. (La Forge)

Taylor producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 317)

Taylor-White process. A process for giving toughness to self-hardening steels. The steel is heated almost to fusion, cooled to a temperature of 700° to 850° C. in molten lead, further cooled in oil, reheated to 370° to 670° C., and cooled in air. (Webster)

Taza (Mex.). 1. The cup or bowl of an *arrastre*. 2. The crucible of a blast furnace. (Halse)

T-Chisel. A boring tool with its cutedge made in the form of the letter T. (Gresley)

Tea lead. A term used in Ceylon for lead manufactured into tea-chest lining.

Team shovel. A scraper or large scoop for moving earth, having guiding handles, and drawn by one or more horses. (Standard)

Tear war! (Newc.). A signal that men are ready at the bottom to ascend the shaft. (Min. Jour.)

Teary ground (Corn.). A lode or stratum that breaks easily by reason of many joint planes. (Pryce)

Teaser. 1. (Scot.) An iron rod for stirring a boiler furnace. (Barrowman)
2. The fireman of a furnace in glassworks. (Standard)

Teaze hole. The opening of a glass furnace through which fuel is introduced. (Standard)

Tebbad (Persian). Literally, "fever-wind"; the hot, scorching winds that sweep across the dry sandy plains of Central Asia, carrying clouds of impalpable sand along with them. (Page)

Technologist. One skilled in technology; one who treats of arts, or of the terms of arts. (Webster)

Technology. Industrial science; the science of systematic knowledge of the industrial arts, as of manufactures, metallurgy, etc. (Webster)

Techo (Mex., Sp.). Roof; hanging wall. (Dwight)

Tecoral (Guerrero, Mex.). Deads; attle; waste. (Halse)

Tecozahuitl (Mex.). The Aztec name for yellow ocher. (Halse)

Tecto (Port.). The hanging wall or roof. (Halse)

Tectonic. Pertaining to the rock structures and external forms resulting from the deformation of the earth's crust. (Webster)

Tectonites. A term used by M. E. Wadsworth to include all mineral construction-material for buildings or roads. (Power)

Tedge. In founding, an ingate in a mold. (Standard)

Tee (Eng.). A cross vein meeting a main vein without intersecting it. (Bainbridge)

Teem. 1. To pour as, steel from a melting pot; to fill, as a mold with molten metal. (Webster)
2. (Eng.) Sometimes Tem. To dump rubbish, etc., down a spoil-bank. (Gresley)

Teemer. A pourer of metal. (Standard)

Teeming hole. A pit containing the mold in which crucible steel is cast. (Standard)

Teeming trough (Lanc.). A cistern (or trough) into which the water is pumped from a mine. (Gresley)

Teeth work (Scot.). A system of working coal end-on. (Gresley)

Teguilote (Guerrero, Mex.). Crystalized quartz. (Halse)

Teja (Sp.). A roofing tile. (Dwight)

Tejo (Mex.). Gold or silver ingot. (Dwight)

Tela de Alambre (Sp.). Fine wire cloth. (Dwight)

Telegraph. A trough-shaped chute for conveying coal or slate from the screens to the pockets. (Chance)

Telford. A road pavement having a surface of small stones rolled hard and smooth, distinguished from macadam road by its firm foundation of large stones with fragments of stone wedged tightly in the interstices. (Webster)

Telfordize. To furnish a road with a telford pavement. (Webster)

Tella (Sp.). A working place. (Halse)

Telltale. 1. Any device serving as a warning. 2. A small overflow pipe indicating by dripping when a tank or cistern is full. (Webster)

Tellurium. A rare element analogous to sulphur and selenium, occasionally a native crystalline substance of tin-white metallic luster, but usually combined with metals, as with gold and silver in sylvanite. Symbol, Te; atomic weight, 127.5; specific gravity 6.27. (Webster)

Telluric bismuth. Same as Tetradymite. (Standard)

Telluric ocher. The mineral tellurite, TeO_2. (Webster)

Telluric silver. The mineral hessite. (Webster)

Telluride. A compound of tellurium with another element or radical (Webster). Often rich in gold and silver.

Telluriferous. Yielding, or containing tellurium. (Standard)

Tellurite. Native tellurium oxide, TeO_2, occurring sparingly in tufts of white or yellowish crystals. (Webster). Called also Telluric ocher.

Tellurium glance. Nagyagite. (Webster)

Telpherage. An automatic aerial transportation system, especially that system in which the carriages having independent motors are run on a stout wire conducting an electric current from which the motive power is derived; an aerial electric tramway. (Standard)

Telurio (Sp.). Tellurium; tellurium ore. (Halse)

Temper. 1. To grind and mix plastic materials, such as clay, or the ingredients of mortar. 2. To give the metals (especially steel) the desired degree of hardness and elasticity by a process of heating and cooling, suitably regulated. A metallic compound in which these qualities can thus be produced is said to temper or to take temper. (Raymond)
3. To anneal or toughen glass. (Webster)
4. An alloy composed of two parts of tin and one of copper, added to pure tin to make the finest pewter.
5. An alloy of arsenic and lead sometimes used for hardening shot. (Standard)

Temperature. A condition with respect to heat or cold, especially as indicated by the sensation produced or by the thermometer or pyrometer; degree of heat or cold. (Webster)

Temperature coefficient. A coefficient expressing a quantitative relation between change of temperature and the consequent variation of some other quantity. (Webster)

Tempered. In brickmaking, (a) moistened and worked to the proper consistency, as clay for bricks or molding. (b) Capable of being cut with ease, as bricks made of such clay. (Standard)

Tempered steel. Steel that has been hardened and subsequently tempered by a second lower heating. (Hibbard)

Temperer. One who or that which tempers; specifically, a machine for mingling and thoroughly working potter's clay, brick-clay, mortar, plaster, or other materials. (Standard)

Tempering. 1. The act of reheating and properly cooling a bar of metal to any desired degree of hardness. (C. and M. M. P.)
2. The process of mixing clays preparatory to molding them. (Ries)

Tempering bar. *See* Furgen.

Tempering furnace. A furnace for heating articles in the process of tempering. (Standard)

Tempering machine. A machine for giving large steel plates a uniform and thorough tempering without permitting them to bend or buckle: usually by pressing them between hot masses of iron, or by firmly clamping them between jaws or plates while immersing them in a tempering bath. (Standard)

Tempering oil. A viscous neutral oil, red in color. A steam-refined cylinder stock equivalent to 26° Bé. Hammer oil is used as a heavy tempering oil, and summer black-oil has been recommended for the same purpose. (Bacon)

Tempering oven. An oven for heating glass in the process of annealing; a leer. (Standard)

Tempering wheel. A wheel mounted on a shaft and revolved in a pit after the manner of an *arrastre*, for kneading and tempering clay. (Standard)

Temper screw. 1. A screw by which well-boring tools are hung from the walking beam and connected and lowered as the work progresses. 2. An adjusting screw. (Standard)

Templador (Peru). A low cylindrical stone placed in the center of a patio, and upon which the mule-driver stands. (Pfordte)

Templar (Sp.). To temper steel, etc. (Dwight)

Templet; Template. A gauge, pattern, or mold, commonly a thin plate or board, used as a guide to the form of work to be executed. (Webster)

Ten (No. of Eng.). A certain weight of coal agreed upon between lessor and lessee, upon which a royalty is paid. A ten varies between 48 and 50 tons, or 18¼ Newcastle chaldrons of 53 cwts. (Gresley)

Tenant helve (Eng.). *See* Frontal-hammer.

Tenate (Mex.). A sack or bag of hide, leather, or cloth for carrying ore. (Halse)

Tenatero (Mex.). A man or boy who carries ore in bags or sacks. (Halse)

Tenazas (Sp.). 1. Tongs. 2. Pincers. 3. Large nippers for extracting broken boring tools. 4. A clip for attaching cars to the rope in endless-rope haulage. (Halse)

Tenderfoot (U. S. and Aust.). A newcomer in a comparatively rough or newly settled region, especially when not inured to the hardship or rudeness of the life. (Webster)

Tender roof (Aust.). A mine roof that requires to be well supported. (Power)

Tending chuck. Pouring water into the hole during rock drilling. (Gillette, p. 24)

Tenedor (Sp.). 1. A guardian or trustee; *T. de libros*, a bookkeeper. 2. A table fork. (Halse)

Tengerite. A mineral of doubtful composition, said to be yttrium carbonate. (U. S. Geol. Surv.)

Tennantite; Gray copper ore. Copper-arsenic sulphide, $3Cu_2S.As_2S_3$. Contains 57.5 per cent copper. Composition varies as in tetrahedrite, into which it grades. (U. S. Geol. Surv.)

Tenon. A projecting tongue fitting into a corresponding cavity called a mortise. (C. and M. M. P.)

Tener. The percentage or average metallic content of an ore, matte, or impure metal. (Weed)

Tenorite. Black oxide of copper in minute black scales, CuO. Contains 79.8 per cent copper (U. S. Geol. Surv.). Called also Black copper.

Tension. A system of forces tending to draw asunder the parts of a body, especially of a line, cord, or sheet, combined with an equal and opposite system of resisting forces of cohesion holding the parts of the body together; stress caused by pulling: opposed to *compression*, and distinguished from *torsion*. (Standard)

Tension fault; Gravity fault. A normal fault.

Tension pulley (Aust.). A pulley around which an endless rope passes mounted on a trolley or other movable bearing so that the slack of the rope can be readily taken up by the pull of the weights. (Power)

Tentadura (Mex.). A sort of assay, made in a horn spoon, in an earthen saucer, or in a wide and shallow vessel of any kind, for the purpose of ascertaining the amount of amalgam present in a sample of argentiferous mud from an amalgamating *patio*. Any assay made by washing or "panning." (Dwight)

Tentale rent (No. of Eng.). A rent or royalty paid by a lessee upon every "ten of coal" that is mined in excess of the minimum or certain rent. *See* Ten. (Gresley)

Tenter (Eng.). A man who has the control or working of an engine or jig, or who looks after the horses in a pit. (Gresley)

Teodolito (Sp.). Theodolite; a surveying transit. (Dwight)

Tepetate (Mex.). 1. Barren rock; attle; deads. 2. Volcanic tuff. 3. Gangue or matrix. 4. Country rock. (Halse) 5. In geology, a secondary volcanic or chemical non-marine deposit, very commonly calcareous, coating the solid rock or penetrating the earthy portions of a district; so-called in Mexico and Central America. (Standard)

Tephrite. In petrology, an aphanitic or aphanophyric igneous rock composed of essential alkali-calcic feldspar, nephelite, and augite, but little or no olivine. Leucite-tephrite contains leucite with or in place of nephelite. (La Forge)

Tephroite. Manganese orthosilicate, $2MnO.SiO_2$. Contains 70 per cent MnO and commonly also small quantities of magnesium, iron, and zinc. (U. S. Geol. Surv.)

Tepostel (Mex.). Oxides of iron and other metals, generally silver bearing. (Halse)

Tepostetes (Sonora, Mex.). Bowlders of specular iron ore found in gold placers. (Dwight)

Tequesquite (Mex.). A native sodium carbonate mixed with some sodium sulphate and common salt, which effloresces, after the rainy season, on the surface of the plains, forming a crust (Century). Also spelled Tequezquite.

Tequio (Mex.). 1. A task set as one day's work. 2. Ore broken from a given place or belonging to a given contractor. 3. In some places, ore not rich enough to sack underground (Dwight)
4. Charges, tax, or duty. (Halse)

Teratolite. A clay from the coal measures of Saxony, formerly supposed to have curative properties. Called also Lithomarge; Terratolite. (Standard)

Terbium. A rare metallic element resembling yttrium. Symbol, Tb; atomic weight, 159.2. (Webster)

Tercero (Sp.). An arbitrator; *T. en discordia*, an umpire between two disputants. (Halse)

Tercio (Mex.). A sack of ore, about 150 pounds weight. A load for a *tenatero*. One-half load for a mule. (Dwight)

Terlinguaite. Oxychloride of mercury, Hg_2ClO. Contains 88.65 per cent mercury. (U. S. Geol. Surv.)

Terminal morain. The transported débris left by a glacier at or near its lower terminus (Standard). *See* Moraine.

Ternary. Consisting of an alloy of three metals; as ternary steel, a steel composed of the usual iron and carbon, alloyed with one other metal. (Webster)

Ternary steel. An alloy steel that contains one alloying element, the term being synonymous with a simple alloy steel. (Hibbard) It contains the one element plus the iron and carbon, hence ternary.

Terne. To coat with an alloy of tin and lead; to make into terne-plate. (Webster)

Terne-plate. A variety of tin plate coated with an alloy of one-third tin, and two-thirds lead. (Raymond)

Terra. The earth. Used as a prefix; as, *terra* cotta. (Webster)

Terra alba. Same as Pipe clay. (Standard)

Terra cariosa. Same as Tripoli. (Standard)

Terrace. 1. A level or nearly level plain, generally narrow in comparison with its length, from which the surface slopes upward on one side and downward on the other side. Terraces and their bounding slopes are formed in a variety of ways, some being aggradational and others degradational. (La Forge)
2. A flaw in marble, commonly cored out and filled up. Also spelled Terras. (Webster)

Terrace epoch. In geology, the earlier part of the Recent or Holocene epoch; also called Terracian: a time of general formation of terraces in the drift-filled valleys of the regions glaciated during the preceding Pleistocene epoch. (La Forge)

Terra cotta. The "baked earth" of the Italians. Kiln-burnt clay assuming a peculiar reddish-brown color fashioned into vases, statuettes and other mouldings. (Roy. Com.)

Terra-cotta clay. A loose term that might include any clay used in the manufacture of terra cotta. (Ries)

Terrain. A variation of terrane.

Terraja (Mex.). A screw cutter. (Dwight)

Terrane. 1. A group of strata, a zone, or a series of rocks. This word is used in the description of rocks in a general, provisional or noncommital sense. (Winchell)
2. A region considered in relation to its fitness for some purpose; an extent of ground or territory. (Standard)

Terranean. Being in, or belonging to the earth. (Webster)

Terraplén (Mex.). Embankment; a graded roadbed; a terrace. (Halse)

Terra ponderósa (L.). Literally "heavy earth"; another name for heavy spar or barite. (Page)

Terra rossa. Red earth due to the weathering of rocks. (Webster)

Terras. In marble-working, a defective or disfigured place in a marble block, which is cut out and filled with a composition (Standard). Also spelled Terrace.

Terra sienna. *See* Ocher.

Terrene. 1. The earth's surface; the earth. 2. In surveying, the surface of the ground. (Webster)

Terreno (Sp.). 1. Land; *T. franco*, land that can be freely conceded by the State for the mining industry. 2. A geological formation, or a group of formations; *T. acuífero*, quicksand; *T. carbonífero*, a carboniferous formation; *T. movedizo*, very soft or loose formation of rocks. (Halse)

Terreplein. An embankment of earth with a broad, level top, which is sometimes excavated to form a continuation of an elevated canal across a valley. (Webster)

Terrero (Sp.). 1. A heap of earth. 2. Waste rock; attle; a mine dump. 3. A deposit of earth accumulated by the action of water. (Halse)

Terrestrial. Consisting of or pertaining to the land in distinction from water. (Webster)

Terre verte. Glauconite, or the similar mineral celadonite, used as a green pigment by artists. (Webster)

Terrigenous. Produced from or of the earth; in geology, deposited in or on the earth's crust. (Standard)

Terrorite. An extra-strong high explosive of the nitroglycerine type. (Standard)

Terroso (Sp.). Earthy. (Halse)

Tertiary. The earlier of the two geologic periods comprised in the Cenozoic era, in the classification generally used. Also the system of strata deposited during that period. (La Forge)

Teschenite. A name given in 1861 by Hohenegger to a group of intrusive rocks in the Cretaceous strata near Teschen, Austrian Silesia. They have, however, been since shown to embrace such a variety of types that the name has little value, but as analcite occurs quite constantly in most of them many still use the term for diabasic rocks with this mineral. (Kemp)

Tessellated. 1. A surface divided in squares, or figures approaching squares, by joints or natural divisions. (Roy. Com.)
2. Composed of tesseræ or small cubes of stone, marble, glass, or terra cotta variously colored and arranged in artistic design; inlaid; mosaic; as *tessellated* pavement. (Standard)

Tessera. A small cube or square, as of stone or glass, for making mosaic or tessellated pavements. (Standard)

Tesseral. In crystallography, same as isometric. (Standard)

Test. 1. A cupel, or cupelling hearth, for refining precious metals; also, a particular portion of metal refined for the purpose of isolating and weighing its gold and silver. *See* Cupel. 2. A procedure or reaction employed to recognize or distinguish any particular substance or constituent of a compound. 3. To refine as gold or silver; to subject to cupellation. (Webster)
4. An apparatus for proving light hydrocarbon oils by heat, to find the temperature at which they evolve explosive vapors; an oil test. (Century)

Testefas. A Russian illuminating oil that possesses a specific gravity of 0.820 to 0.823 and a flash-point of not below 38° C. (Bacon)

Testera. 1. (Sp.) A dike interrupting the course of a lode. 2. A solid bed of mineral having two faces exposed; *T. de guía*, a gallery driven along a deposit. 3. Front of a blast furnace. (Halse)
4. *Testeras* (Mex.). Uprights in a mine, whether pillars, arches, or posts. (Dwight)

Test hole. 1. A tap hole, as in a cementation-furnace. (Standard)
2. A drill hole or shallow excavation for testing an ore body; a test pit.

Test lead. Lead free from any silver, and often finely granulated, used in testing or cupelling, assaying, etc. (Webster)

Test paper. A chemically prepared paper that changes color when brought into contact with certain substances, particularly acids and alkalies (George). *See* Litmus paper.

Test pit. A shallow pit sunk in search of mineral. (Weed)

Test plate. A white plate or tile on which to try vitrifiable colors by heat. (Standard)

Test ring. An oval iron frame for holding a test or movable cupelling hearth. (Raymond)

Test tube. A tube for simple chemical tests, usually a plain tube of thin glass closed at one end, but sometimes having a foot, bulb, graduated scale, or other modification. (Webster)

Testudo (L.). A large shield-like shelter used by miners while working in places likely to cave in. (Standard)

Tetartohedral. Having one fourth the number of planes requisite to the symmetry of a crystal. (Webster)

Tetrachloride. A chloride having four atoms of chlorine in the molecule. (Webster)

Tetradymite. Bismuth telluride, $Bi_2(Te,S)_3$. Contains theoretically 51.9 per cent bismuth, but the actual content ranges from 50.4 to 52.8 per cent. Sulphur generally replaces part of the tellurium, and the mineral sometimes contains a trace of selenium. The sulphurous variety contains from 57.7 to 62.2 per cent bismuth and may be represented by the formula $2Bi_2Te_3.Bi_2S_3$. Gold, copper, and iron are present in some tetradymites. (U. S. Geol. Surv.)

Tetragonal. Designating, or belonging to, a system of crystallization having all three axes at right angles and the two lateral axes equal. (Dana)

Tetragonal system. That system of crystals in which the forms are referred to three mutually perpendicular axes, two of which are of equal length and the third longer or shorter. (La Forge)

Tetrahedrite; Gray copper ore. Copper-antimony sulphide, essentially $3Cu_2S.Sb_2S_3$. Contains 52.1 per cent copper. In many tetrahedrites the copper is partly replaced by iron, lead, zinc, mercury, and silver, and the antimony by arsenic. Through the last replacement tetrahedrite grades into tennantite (U. S. Geol. Surv.). Called also Fahlerz.

Tetrahedron. A crystal form, in the isometric system, enclosed by four faces having equal intercepts on all three axes. (La Forge)

Tetrahexahedron. A crystal form of the isometric system bounded by twenty-four equal triangular faces, four to each face of the cube. (Dana)

Tewel. 1. A hole; a bore; a chimney, as for smoke. 2. The tuyère of a furnace. (Webster)

Textura (Sp.). Texture. (Dwight)

Texture. The character, arrangement, and mode of aggregation of the fragments, particles, or crystals that compose a rock; the sum total of those features of a rock which determine its physical structure and appearance as a rock.
Texture and *structure* have been and still are used more or less interchangeably, but there is a growing and commendable tendency to confine *structure* to the features that characterize the rock mass, as a part of the earth's crust, and *texture* to those that characterize the particular specimen, as a piece of rock. Thus the *structure* of a rock may be, for example, stratified or slaty or brecciated, and its *texture* may be, for example, clastic or crystalline or glassy. (La Forge)

Thalassic rocks. Strata formed in deep, still water, far from shore lines, generally composed of very fine particles of material; contrasted with Littoral rocks. (Standard)

Thallium. A rare metallic element of the aluminum group, resembling lead in physical properties. Symbol, Tl; atomic weight, 204.0; specific gravity, 11.8 (Webster). Used in alloys and glass-making.

Thallium glass. A variety of flint glass of great density and refracting power; made by using thallium in place of lead. (Standard)

Thanet sands. The lowest beds of the Eocene Tertiary in England. (Standard)

Tharu. A gold-washing race in Champaran, Nepal, Northern India. (Lock)

Thaw house. A small building, designed for thawing dynamite, of such size as to provide enough thawed dynamite for the day's work. Thawing houses should be heated either with hot water or exhaust steam in such a manner that the explosives can not come in contact with the heated metal or lie directly over the heated metal. (Du Pont)

Thawing. The warming of frozen dynamite until it becomes soft and plastic. Thawing should be done carefully, slowly, and according to directions issued by the manufacturers of the explosives. (Du Pont)

Thawing kettle. A double kettle, built somewhat like a farina boiler, having two compartments, an outer compartment, which is filled with hot water and which entirely surrounds the inner compartment that contains the dynamite to be thawed. It is provided with a lid for retaining the heat. (Du Pont)

Theats (Scot.). A horse's draw-chains. (Barrowman). Trace chains.

Thenardite. A native sodium sulphate, Na_2SO_4. (U. S. Geol. Surv.)

Thenard's blue. Same as Cobalt blue.

Theodolite. An instrument for measuring horizontal, and usually also vertical, angles. It consists of a telescope mounted so as to swivel vertically in Y's secured to a revolvable table carrying a vernier for reading horizontal angles. There is usually a graduated arc, or circle of altitudes. A horizontal compass is commonly included. (Webster)

Theralite. A granular igneous rock composed essentially of andesine, nephelite, and pyroxene, with or without a little hornblende, biotite, or olivine. (La Forge)

Thermal. Hot; warm. Applied to springs which discharge water heated by natural agencies. (Thompson)

Thermal conductivity. Capability to conduct heat; the quantity of heat that passes in unit time through a unit area of a plate whose thickness is unity when its opposite faces differ in temperature by one degree. (Webster)

Thermal unit. A unit chosen for the comparison, or calculation, of quantities of heat, as the calorie or the British thermal unit. (Webster)

Thermite; Thermit. A mixture of aluminum in fine grains or filings with some metallic oxide, usually of iron or chromium; on being heated by a priming, as of magnesium powder, the aluminum combines violently with the oxygen of the oxide, setting free the metal, producing a fluid slag, and generating great heat. Is used in welding steel. (Webster)

Thermite process. The process of welding steel with thermite. Also known as Goldschmidt's process. (Webster)

Thermites. A term used by M. E. Wadsworth to include mineral fuels or burning-materials. (Power)

Thermoaqueous. Produced by, or related to, the action of heated waters. (Raymond)

Thermochemistry. That branch of chemical science which treats of the relations existing between chemical action and heat. (Webster)

Thermodynamics. The science which treats of the mechanical action or relation of heat. (Webster)

Thermoelectricity. Electricity produced by the direct action of heat, as by the unequal heating of a circuit composed of two dissimilar metals. (Webster)

Thermometamorphism. Metamorphism in which the dominant agency is heat. (Watson, p. 204)

Thermometer. Any device for measuring temperature. *See also* Pyrometer.

Thermopile. An apparatus consisting of a number of thermoelectric couples, used to generate electric currents for determining slight differences of temperature. (Webster)

Thermostat. An automatic device for regulating temperature by utilizing the expansion of solids, liquids, or gases, subjected to heat, as in opening or closing the damper of a furnace, regulating the supply of gas, etc. (Webster)

Thetis' hair-stone. An old name for rock crystal containing acicular crystals of actinolite. (Chester)

Thick coal; Thick seam (Eng.). A coal seam of greater thickness than (say) 8 or 10 feet (sometimes as much as 130 feet), or those which are worked in two or more stages or lifts. (Gresley)

Thickened oils. Mineral oils thickened by dissolving in them small amounts of vulcanized rubber or of aluminum soap; they are intended for certain lubricating purposes. (Bacon)

Thickness. 1. The distance at right angles between the hanging and the foot wall of a lode or lens. 2. In founding, material, as loam, set in a mold to a certain thickness, to be partially displaced by a templet. (Standard)

Thies process. A chlorination process for recovering gold from its ore. For each ton of ore in a revolving drum, 130 gallons of water, 30 pounds chloride of lime, and 36 pounds concentrated sulphuric acid are added, and the drum revolved for some time. A solution of chloride of gold is thus obtained. The silver remains as an insoluble chloride, which can be separated by the addition of sodium hyposulphite solution. (Goesel)

Thill. 1. (Newc.) The floor of a coal mine. (Raymond)
2. A thin stratum of fire clay. (Webster)

Thimble. 1. An oval iron ring around which a rope end is bent and fastened to form an eye. (C. M. P.)
2. (Aust.). The iron ring, placed a few feet below the head-frame pulley, which supports the safety detaching hook in case of an overwind. (Power)
3. A metal socket for fixing a lead pipe to stoneware. (Webster)

Thimble joint. A sleeve joint packed to allow longitudinal expansion. A slip expansion joint. (Nat. Tube Co.)

Thing. 1. (No. Staff.) A straight facing from floor to roof, often many yards in length. 2. (Mid.) A fault slip. (Gresley)

Thinolite. A tufa deposit of calcium carbonate occurring on an enormous scale in northwestern Nevada; also occurs about Mono Lake, California. It forms layers of interlaced crystals of a pale yellow or light-brown color and often skeleton structure except when covered by subsequent deposit of calcium carbonate. (Dana)

Thin out. Applied to beds or strata which grow gradually and continually thinner in one direction, until they entirely disappear. (Thompson)

Thin seam; Thin coal (Eng.). A coal seam less than 3 feet in thickness. (Gresley)

Thin section. A fragment of rock or mineral ground to paper thinness, polished, and mounted between glasses as a microscopical slide. Rocks and most minerals except the oxides and sulphides of the metals are translucent to transparent in thin section and the optical properties of each mineral can be studied with the miscroscope. (Ransome)

Thin stock. Slabs of stone employed for wainscoting, flooring, etc. (Bowles)

Third-hand asistant (Aust.). A boy who helps the machinist and his assistant with a coal-cutting machine. (Power)

Thirl; Thirling. 1. (Scot.) A cross-hole or ventilation-passage between two headings. 2. In the North of England lead mines, a mark at the end of a pitch or set (Standard). *See* Thurl; Thurling.

Thirling. *See* Thirl.

Tholeiite. Rosenbusch's name for augite-porphyrites, which, aside from the usual phenocrysts, have a groundmass, with but one generation of crystals and with a little glassy basis between them, affording a texture called intersertal. (Kemp)

Thomäite. A variety of siderite that is found massive and in pyramidal crystals. (Standard)

Thomas-Gilchrist process. Bessemerizing (which *see*) pig iron, high in phosphorus and low in sulphur, in a converter lined with calcined dolomite. The slag formed consists of a basic calcium phosphate which is used for fertilizer (Liddell). A basic-lining process.

Thompsonolite. A fluoride of calcium, aluminum, and sodium, $NaCaAlF_6 \cdot H_2O$. (Webster)

Thompson process. A process of electric welding in which heat is developed by a large current passing through the metal. (Webster)

Thomsonite. Hydrous sodium-calcium-aluminum silicate. $(Na_2Ca)O.Al_2O_3.2SiO_2.2\frac{1}{2}H_2O$. One of the zeolites, sometimes used as a gem. (U. S. Geol. Surv.)

Thoria. The oxide of thorium, ThO_2.

Thorianite. A mineral of complex and uncertain composition but consisting chiefly of thorium and uranium oxides with minor quantities of many other bases. Contains about 12.1 per cent U_3O_8 and 71 per cent ThO_2. (U. S. Geol. Surv.)

Thorite. 1. A rare mineral of a brown to black color, consisting essentially of thorium silicate, $ThSiO_4$. 2. A high explosive used as a bursting charge for shells. (Webster)

Thorium. A comparatively rare metallic element occurring in combination in thorite, monazite, and certain other minerals and isolated as an infusible, gray, metallic powder. Symbol, Th; atomic weight, 232.4; specific gravity, 11.1. (Webster)

Thorofare. In geology, a channel cut across a spit or barrier beach. (Watson, p. 388)

Thorogummite. A hydrous silicate of uranium and thorium, $UO_2.3ThO_2.3SiO_2.6H_2O$. Contains 22 per cent UO_2 and 41 per cent ThO_2. (U. S. Geol. Surv.)

Thrackscat (Eng.). Metal or mineral still in the mine. (Standard). An obsolete term.

Thread. 1. An extremely small vein, even thinner than a stringer. (Roy. Com.)
2. (Mid.) A small wooden wedge; *see* Cleat, 3. 3. A more or less straight line of stall faces, having no cuttings, loose ends, fast ends, or steps. (Gresley)

Three-high train. A roll-train composed of three rolls, the bar being entered on one side between the bottom and the middle roll, and on the other side between the middle and the upper roll. The passes in both directions thus take place without reversing the movement of the rolls, as is done in so-called reversing rolls. (Raymond)

Threeling. In crystallography, a group of three crystal individuals united by the same twinning law. (Standard)

Three-quarter coal. A mixture of lump and nut coal. (Nicolls)

Three trees (Eng.). A kind of ladder used in mines. (Bainbridge)

Throstlebrest (Derb.). An ore with much gangue adhering, so that it requires a great deal of knocking or breaking to make it marketable (Hooson). Also spelled Throstlebreast.

Throttle. 1. To obstruct the flow of, as steam to an engine. 2. A valve for regulating the supply of steam, gas or air to an engine. (Webster)

Through; Thirling. A passage cut through a pillar to connect two rooms. (Ihlseng)

Through and through (Wales). Mining bituminous coal without regard to the size of the lumps (Gresley). *See* Through coal.

Through Coal. (Wales). Large and small coal mixed; altogether coal; run of mine.

Througher (Scot.). A crosscut between two headings. (Gresley)

Through stone. A stone passing entirely through the thickness of a wall; a bond-stone; perpend. (Standard)

Throw. 1. A fault, a dislocation. (Chance)
2. The amount of vertical displacement up (upthrow) or down (downthrow) produced by a fault; sometimes, loosely, a dislocation not vertical, the direction being specified (Webster). *See* Heave; Perpendicular throw; Stratgraphic throw. (Lindgren, p. 120)
3. In ceramics, to form or shape on a throwing engine, or potter's wheel, as earthen vessels. (Webster)
4. (Local Eng.) To break out the pillars (a coal mine), leaving the hanging coal unsupported. *See* Spur, 1. (Standard)

Throw crook. A potter's wheel; throwing table. (Standard)

Thrower. One who uses a throwing wheel; a potter. (Standard)

Throwing (So. Staff.). The operation of breaking out small pillars, so as to leave the hanging coal unsupported, except by its own cohesion. (Raymond) *See* Throw, 4.

Throwing clay. Clay plastic enough to be shaped on a potter's wheel. (Standard)

Throwing engine. 1. A potter's wheel with its supports, used in throwing (Webster). Called also Throwing machine; Throwing mill; Throwing wheel. 2. *See* Throw, 3.

Throwing house. A building in which clay is thrown on potters' wheels. (Standard)

Throwing table. A potter's wheel. (Standard)

Thrown. 1. Faulted or broken up by a fault. (Gresley)
2. Turned, as a piece of ceramic ware on a potter's wheel. (Standard)

Throw-off. A kind of derailing switch. (Webster)

Throw-off switch (Aust.). A switch by means of which an obstruction is thrown across the rails of a track, causing the derailment of the trucks (Power). A derailing switch.

Thrust. 1. A crushing of coal pillars caused by excess weight of the superincumbent rocks, the floor being harder than the roof. Nearly the same as creep, except that in the latter the workings are disorganized by the upheaval of the floor, which being softer than the roof is the first to yield. *Compare* Creep. (Century)
2. The ruins of the fallen roof, after pillars and stalls have been removed. (Raymond)

Thrust fault. *See* Fault.

Thrust plane. The plane of a thrust or reversed fault. (La Forge)

Thud (Eng.). A dull and heavy report made by the rending of the strata far overhead when the coal has been extracted. (G. C. Greenwell)

Thulite. A pink mineral of the epidote group, which owes its color to the presence of manganese (Ransome). *See also* Zoisite.

Thulite stone. A pink or rose-colored siliceous rock from Norway, composed chiefly of quartz and thulite; used for small ornaments. (Standard)

Thulium. A rare metallic element resembling ytterbium, found in combination in gadolinite. Symbol, Tm; atomic weight, 168.5. (Century)

Thum-Balbach process. A silver-refining process using carbon cathodes, doré anodes, and a silver-nitrate nitric-acid electrolyte. The silver is scraped off the bottom as crystals. (Liddell)

Thum furnace. A gas-fired furnace especially for the treatment of zinc ore which is high in lead. (Ingalls, p. 492)

Thunderbolt. 1. A stone or stony concretion, especially if elongated and tapering, found in the ground and ignorantly supposed to have fallen from the sky. 2. A nodule or mass of iron pyrite found in English chalk formations. (Standard)

Thunder stone. Same as Thunderbolt.

Thuringian. In geology, designating the upper division of the European Permian. (Webster)

Thurl (So. Staff.). To cut through from one working into another (Raymond). *Also* Thirl.

Thurling. A passage cut from room to room, in post-and-stall working (Raymond). *Also* Thirling.

Thurm. 1. In mining, a small displacement or fault of a seam. (Standard)
2. (Nova Scotia) A ragged, rocky headland swept by the sea; also called Thurm cap. (Century)

Thwack. In tile making, to beat into shape. (Webster)

Thwacker. One that thwacks; specifically, in tile making, a wooden implement with which the half-dried pantile is beaten to take out any warping that has occurred. (Webster)

Thwacking frame. A table, with curved top, used in thwacking a pantile. (Standard)

Thwacking knife. A knife used to trim pantiles after thwacking. (Standard)

Thwarting (Som.). A short road driven between two or more veins where they are nearly vertical. (Gresley)

Tiatales (Guerrero, Mex.). A hard limestone. (Halse)

Tibe (Colom.). 1. A hard, smooth, flat or rounded stone, found in alluvial mines. 2. Corundum, used by the ancient Indians for polishing tools. (Halse)

Tibir (Sp.). Gold dust found on the African coast. (Halse)

Ticket. 1. (Scot.) An old measure for coal. The Campbeltown ticket was about 300 pounds. (Barrowman).
2. (Eng.) A sealed bid for ore to be sold. (Webster)
3. The numbered check which the miner puts on his loaded car to inform the weigh master to whom the coal belongs (Roy.). *See also* Tag; Tally.

Ticketing. In English mining districts, a periodical sale of ore to the highest bidders by ticket. *See* Ticket, 2. (Standard)

Tick hole. A small cavity in a rock; a vug.

Tidewater glacier. A glacier whose foot dips into tidewater, and which often produces icebergs. (Standard)

Tie. 1. A beam, post, or rod to hold parts together; a tension member in a structure. 2. Any of the transverse supports to which railroad rails are fastened. (Webster)
3. (Eng.). A level; also, a support for the roof in coal mines. (Bainbridge)

Tie-back. 1. A beam serving a purpose similar to a fend-off beam, but fixed at the opposite side of the shaft or inclined road. 2. The wire ropes or stayrods that are sometimes used on the side of the tower opposite the hoisting engine, in place of or to reinforce the engine braces. (C. and M. M. P.)

Tie band (Eng.). A piece of rope used in securing long timbers or rails when being sent down in the cage. (G. C. Greenwell)

Tiebar. A bar used as a tie, as between two switch rails to hold them to gage. (Webster)

Tiemannite. Mercuric selenide, HgSe. Contains 71.7 per cent mercury and 28.3 per cent selenium. (U. S. Geol. Surv.)

Tienda de raya (Sp.). A store at which the miners obtain weekly credit. (Min. Jour.)

Tie plate. A protecting metal plate between the rail and tie. (Webster)

Tie rod. A round or square iron rod passing through or over a furnace and connected with buckstaves to assist in binding the furnace together.

Tierra (Sp.). 1. Earth, land, soil, ground; *T. arcillosa*, clay ground. 2. Region of the earth; *T. adentro*, the interior of a country. 3. Any rock or mineral; *T. blanca* (Mex.) a calcareous tufa; *T. de batan*, fuller's earth; *T. de flor* (Venez.) A bed of reddish clayey earth; *T. de porcelana*, china clay; *T. pesada*, heavy spar (Halse)
4. (Mex.) Fine sized ore. (Dwight)

Tierra blanca (Sp.). White, chalky, limestone beds, having special value for hydraulic cement. (Standard)

Tierras (Sp.). 1. Fine material impregnated with quicksilver ore, which must be made into adobes before roasting. (Raymond)
2. *T. de labor*, rock from a stope mixed with particles of ore; fines; *T. de yunque*, smalls produced in breaking and sorting ore; *T. Pardas* (Mex.) An alluvial formation containing limonite; *T. rojas*, a ferruginous clay. 3. Ore generally in a fine state of division. 4. Gangue or matrix. (Halse)
5. Any low-grade, powdered ore. (Standard)

Tiers-argent (Fr.). An alloy of one part of silver to two of aluminum. (Standard)

Tier saw. A saw for giving bricks curved outlines. (Standard)

Tiesteros (Bol.). Men who make tests or assays of ore before amalgamation (Halse). Assayers.

Tiff. 1. A common name for calcite in Wisconsin and Missouri zinc fields. 2. Barite in southeast Missouri.

Tiffanyite. A name proposed by Kunz for a hydrocarbon assumed to be present in certain diamonds, namely, those which, on this account, exhibit fluorescence and phosphorescence. (Bacon)

Tiger. A device, as a fork, for supporting a continuous series of well-boring rods or tubes while raising or lowering them in the hole (Standard). *See* Nipping-fork.

Tiger-eye. 1. A chatoyant stone, usually yellow-brown, much used for ornament. It is silicified crocidolite, in which the fibers penetrating the quartz are changed to oxide of iron. 2. A potter's glaze resembling in look the tiger-eye. (Webster)

Tightset. A quarrymen's term, equivalent to blind seam, or incipient joint. (Dale)

Tile. 1. A thin plate or piece of baked clay, stone, or the like of a kind used for covering roofs of buildings, for floors, for drains, and often for ornamental work. 2. A small flat piece of dried earth or earthenware, used to cover vessels in which metals are fused. (Webster)

Tile copper. Copper obtained by roasting and refining the metal bottoms that collect under the regulus in smelting certain impure ores; usually cast in flat rectangular plates, hence its name (Standard). *See* Bottoms, 2.

Tile earth (Prov. Eng.). A compact clay soil. (Standard)

Tile field. A field or yard, as at a pottery, devoted to the construction of tiles. (Standard)

Tile kiln. A kiln for vitrifying tiles. (Standard)

Tile machine. A machine for making tubular or arch-shaped tiles from clay, operating by forcing the raw material through a die, in a continuous stream, which is cut into suitable lengths by wires. (Standard)

Tile ore. A massive variety of cuprite, of brick-red color. (Chester)

Tile oven. An oven for burning tiles. (Standard)

Tiler. 1. A kiln or oven for baking tiles. 2. A maker or layer of tiles. (Standard)

Tilery. A factory in which tiles are made. (Standard)

Tilestone. 1. Any of several beds of shale or sandstone, often red in color, belonging to the upper part of the Ludlow group, English Upper Silurian. (Webster)
2. A tile, particularly of stone; a brick. (Standard)

Tile works. A tilery or tile field. (Standard)

Tilgate stone. Beds of calcareous sandstone or ironstone near Hastings, England. (Century)

Till. That part of a glacial drift consisting of material deposited by and underneath the ice, with little or no transportation and sorting by water; it is a generally unstratified, uncon-

solidated, heterogeneous mixture of clay, sand, gravel, and bowlders. Also called Bowlder-clay (La Forge). Two kinds are recognized: (1) *Glacier-till*, deposited directly by glacier-ice, not by glacier-waters, though it may be locally modified by them. Contrasted with Glacier-sediment. It may be (a) englacial (carried within the ice-mass), (b) superglacial (borne on the ice surface), or (c) subglacial (dragged along beneath the glacier), and in this case called also Ground-moraine or Bowlder-clay. (2) *Berg-till*, detrital matter deposited by icebergs. Called also Subaqueous till or Floe-till. (Standard)

Tiller (Eng.). An instrument similar to a brace head, but usually made of iron, for turning drill tools. (Gresley)

Tiller rope. A flexible wire rope composed of six small ropes, usually of seven-wire strands each laid about a hemp core. (C. M. P.)

Tillite. A sedimentary rock composed of cemented till. (La Forge)

Tilt. 1. To hammer or forge with a tilt (trip) hammer. (Webster) 2. A tilt hammer. (Standard)

Tilted steel. Hammered steel. (Standard)

Tilter. 1. One who forges metal with a tilt-hammer. 2. A tilt hammer. (Standard)

Tilt hammer. A hammer for shingling or forging iron, arranged as a lever of the first or third order, and "tilted" or "tripped" by means of a cam or cog-gearing and allowed to fall upon the billet, bloom, or bar. (Raymond)

Tilt mill. A mill where metal, as steel, is tilted. (Webster)

Timazite. A name given by Breithaupt to certain porphyritic rocks in the Timok Valley of Servia, that have since proved to be varieties of andesite and dacite. (Kemp)

Timba (Sp. Am.). Logs used for the roof of a mine. (Halse)

Timber. 1. Any of the wooden props, posts, bars, collars, lagging, etc., used to support mine workings. 2. To set or place timbers in a mine. 3. One of the steel joists or beams, which have in some mines replaced wooden timbers. (Webster)

Timberer; Timberman. One who cuts, frames and puts in place any of the timbers used in a shaft, slope, mine or tunnel. Also one who draws props, posts, etc.

Timbering. 1. (Eng.) The timber structure employed for supporting the faces of an excavation during the progress of construction (Simms) 2. Timber work taken collectively, as in a mine. (Standard)

Timberline. The height on mountains at which the growth of trees stops. It varies with the latitude and climate. (Webster)

Timberman. *See* Timberer.

Timber packer (Washington). A laborer who delivers timber to the working place in a pitching or inclined coal seam.

Timber rights. The right to cut timber on the public domain for use in the mining industry. (U. S. Min. Stat., pp. 1384–1353)

Timbre (Mex.). 1. A bell. 2. A stamp tax. (Dwight)

Timbrero (Mex.). Bell man. (Dwight)

Time. 1. A statement of the number of days or hours worked by, or of the amount of wages due a workman; usually furnished him upon request in the event of his quitting work before the regular pay day. 2. To count the strokes of a pump, or revolutions of an engine or fan. C. and M. M. P.)
3. In geology, a general term indicating a subdivision of one of the grander divisions of geological history; as, Palezoic *time*. (Standard)

Timekeeper. One whose duty it is to make and keep a record of the number of hours or days worked by laborers or other employees.

Timpa (Sp.). A tymp stone in front of the hearth of a blast furnace. (Halse)

Tin. 1. A chemical element obtained as a soft, lustrous white, crystalline metal, malleable at ordinary temperature but brittle when hot. Symbol, Sn; atomic weight, 118.70; specific gravity, 7.28. (Webster)
2. To coat with tin; as *to tin* iron.
3. Tin plate. (Standard)

Tina (Mex.). 1. A mine bucket or tub. 2. A leaching vat (Dwight); *T. cargadora*, a tank into which the slimes are first discharged. (Egleston)

Tinaco (Sp.). A wooden trough, tub, or vat, used in leaching. (Halse)

Tinaja (Mex.). 1. A basin of water in a rock. (Dwight) 2. A large earthen jar. 3. Small bunches of cinnabar. (Halse)

Tin bath. Molten tin into which sheets of iron are dipped in order to form tin plate. (Standard)

Tin bound. 1. (Corn.) To mark a limit, as on a tract of waste land, within which one claims or reserves the right to mine unworked tin ore. 2. Land so reserved. (Standard)

Tincal. Crude native borax, formerly imported from Tibet (Webster). Also spelled Tinkal.

Tincalconite. A pulverulent variety of borax, with thirty-two per cent of water. (Chester)

Tin-can safety lamp. A Davy lamp placed inside a tin can or cylinder having a glass in front, air holes near the bottom, and open-topped. (Gresley, 1883)

Tinca (Peru). A small mine timber. (Pfordte)

Tinder ore. An early name for an impure variety of jamesonite, resembling tinder. (Chester)

Tin dish. A pan used by prospectors for washing gold-bearing materials and extracting the gold. (Duryee)

Tin floor. 1. (Corn.) A thin flat mass of tinstone between beds of rock. 2. An irregular mass of tin ore. (Standard)

Tin foil. Tin or a tin-like alloy made into foil. (Standard)

Tin frame (Corn.). A sloping table used in dressing tin-ore slimes and discharged by turning it upon an axis till its surface is nearly vertical, and then dashing water over it, to remove the enriched deposit. A machine frame or self-frame thus discharges itself automatically at intervals; a hand-frame is turned for the purpose by hand. (Raymond)

Ting. Same as Sycee-silver. (Standard)

Tin glass. A name formerly applied to bismuth. (Ure)

Tin glaze. An opaque glaze of stannic oxide, used on pottery. (Standard)

Tinguaite. A variety of phonolite rich in aegirite (La Forge). A name given by Rosenbusch to rocks consisting of alkali feldspar, nephelite and abundant aegirine, which form dikes in or near areas of nephelite-syenite. It was first applied to specimens from the vicinity of Rio Janeiro, where in the Serra de Tingua the rocks were first discovered and described by O. A. Derby as phonolites. They have since proved of very wide distribution and not always to accompany nephelite-syenites. By many the name tinguaite is regarded as an unnecessary and undesirable synonym for Phonolite. (Kemp)

Tinker (Derb.). Laminated carbonaceous shale. (Gresley)

Tin liquor. A solution of tin in strong acid, used as a mordant in dyeing. (Century)

Tinned rope. Rope made of wires that have been coated with tin to protect them from corrosion. (C. M. P.)

Tinned sheet iron. *See* Tin plate.

Tinner. 1. (Corn.). One who works in a tin mine. 2. A tinsmith. (Webster)

Tinning. 1. The act, operation, or process of covering with or preserving in tin. 2. A protective coating of tin, as on sheet iron. (Standard)

Tinning metal. An alloy of equal parts of tin and lead: used by electrotypers for coating copper shells before backing. (Standard)

Tin penny (Eng.). A local tax formerly paid for permission to engage in tin mining. (Standard)

Tin pickling. In the manufacture of tin plate, the process of immersing thin iron plate in a bath of acid, previous to tinning. (Standard)

Tin-pickling machine. A machine for hoisting and lowering the plates in the process of pickling and washing. (Standard)

Tin plate. Sheet iron or steel coated with tin by dipping into the melted metal: commonly called simply Tin. There are three principal qualities: the best, consisting of coated charcoal iron, is called Charcoal plate; that which is coated on coke-smelted or puddled iron is called Coke plate, and tin plate having crystals formed by the action of diluted nitric and hydrochloric acids is called Crystallized tin plate. (Standard)

Tin pot. 1. A vessel for holding molten tin. 2. A bath of molten tin in which sheet-iron or sheet-steel is dipped in making tin plate. (Standard)

Tin pyrites. Same as Stannite. (Standard)

Tinsel. To give a metallic appearance to (ceramic ware) by washing with a metallic substance. (Standard)

Tin spar. A synonym for Cassiterite. (Chester)

Tinstone. A miner's name for Cassiterite. (Standard)

Tin stuff (Eng.). Tin ore mixed with its gangue. (Standard)

Tintero (Peru). The sump of shaft. (Dwight)

Tin-white cobalt. A synonym for Smaltite. (Chester)

Tin-witts (Corn.). The product of the first dressing of tin ores, containing, besides tinstone, other heavy minerals (wolfram and metallic sulphides). It must be roasted before it can be further concentrated. Its first or partial roasting is called rag-burning. (Raymond)

Tin works. A place or an establishment where tin is manufactured or mined. (Standard)

Tip; Tipple (Eng.). A platform upon which a pair of iron tram rails, fixed upon an axle and attached to a lever, are bolted down, for emptying tubs or cars into wagons, boats, bins, etc. (Gresley)

Tipper. 1. An apparatus for emptying cars of coal or ore, by turning them upside down and then bringing them back to the original position with a minimum of manual labor. Tipple is the common name. (Steel)
2. (Aust.) The man who runs skips into a tippler. (Power)

Tipple. 1. The place where cars are tipped or dumped; the dump; a cradle-dump. (Chance)
2. (Aust.) The tracks, trestles, screens, etc., at the entrance to a colliery where coal is screened and loaded (Power). *See* Tipper, *also* Tip.

Tippler (Aust.). An apparatus for tipping a skip, so as to empty it of its contents (Power). *See also* Tip; Tipper, and Tipple.

Tirada (Sp.). 1. Hoisting of a cage. 2. One complete hoist. (Halse)

Tirante (Sp.). 1. Small hewn timber. 2. The tie rod of a boiler. 3. A pump rod. 4. (Mex.) A large beam. (Halse)

Tirar (Sp.). 1. To hoist or wind. 2. To blast or shoot. 3. *T. una labor* (L. Cal., Mex.), prospecting; placer mining. (Halse)

Tiro (Mex.). 1. Mine shaft or pit; *T. de arrastre*, or *de recueste*, an inclined shaft; *T. general*, the main shaft; *T. vertical*, a vertical shaft; 2. (Colom.) An airshaft; a raise. 3. *T. de aire*, an air blast; an air current. 4. *T. de mulas*, a team of mules. 5. A blast or shot. 6. Hoisting or winding. 7. A rope used in hoisting. 8. (Chile) A drill hole. (Halse)

T-iron. 1. An angle iron having T-shaped cross-section. (Standard)
2. T-rails used in a mine, as distinguished from wooden rails.

Tirón (Sp.). A tug or jerk given to a rope in hoisting. (Halse)

Tirr. 1. (Scot.). The covering on rock in a quarry; overburden. Also Tirring. 2. (Scot.) To remove the covering from the rock in a quarry. (Barrowman)

Tisar. In plate-glass making, a heating furnace for an annealing chamber. (Standard)

Titan. 1. Titanium. 2. Titanite. (Standard)

Titanic anhydrite. A white pulverulent titanium oxide (TiO_2) found native as brookite, octahedrite, and rutile, and a common constituent of iron ores. Called also Titanic oxide.

Titanic iron ore. Ilmenite, $FeTiO_3$. (Webster)

Titanic schorl. Rutile. (Standard)

Titaniferous. Carrying titanium, as titaniferous iron ore. *See* Ilmenite. (Roy. Com.)

Titanio (Sp.). Titanium (Dwight). *See* Agulhas.

Titanite; Sphene. Calcium silicotitanite, $CaTiSiO_5$ (Dana). A fairly common but rarely abundant constituent of some igneous rocks. Generally yellow or brown with waxy luster. Can frequently be recognized without the aid of a lens. (Ransome)

Titanium. A metallic element found in nature only in combined form, and isolated as an infusible iron-gray crystalline powder. Symbol, Ti; atomic weight, 48.1; specific gravity 3.55 (Webster)

Tithe ore (Eng.). A portion of ore set aside for the payment of rental or royalty on mineral lands.

Titration. An analytical process consisting in the addition of a liquid in measured volume to a known volume of another liquid or to a known weight of a substance, till a certain definite effect, usually a change of color is observed (Webster). Volumetric analysis.

Titulo (Sp.). Title; *T. de propiedad,* title to a mining claim. (Halse)

Tiza (Sp.). 1. Ground chalk or whiting. 2. Finely divided gypsum. 3. (Chile) A mixture of ulexite with chlorides and sulphates of sodium and calcium, and sand. An important source of borax. (Halse)

Tizar (Durango, Mex.). A white pure silica used in glass making. (Halse)

Tizón (Mex.) A bond in masonry. *See also* Diente, 2. (Dwight)

Toadrock. *See* Toadstone.

Toad's-eye tin. Massive cassiterite in botryoidal and reniform shapes. (Standard)

Toadstone (Eng.). A kind of trap rock. (Raymond)

Toas (Corn.). To shake or toss tin ore in a kieve or vat with water, to cleanse and dress it. (Pryce)

Toba (Mex.). 1. Volcanic tuff. 2. *T. caliza,* calcareous tufa (Dwight). 3. (Colom.) Chalk. (Halse)

Tobera (Mex.). The tuyère of a smelting furnace. (C. and M. M. P.)

Toca (Braz.). Quality of gold. *Compare* Ley, 2. (Halse)

Todouno (Sp.). 1. Coal as it comes from the mines. Run of mine. (Halse)
2. Raw, rough ore. (Lucas)

Toe. 1. The burden of material between the bottom of the bore hole and the free face. 2. It is sometimes used to designate the bottom of the bore hole itself as distinguished from the heel, collar or mouth of the bore hole, which is the open end. (Du Pont)
3. A spurn, or small pillar of coal. (Gresley)
4. The front end of a frog, opposite the heel, in a car track.

Toeing-in. A quarry term for the wedging-in of the end of a granite sheet under an overhanging joint, probably in consequence of the faulting of the sheets along the joint. It is also applied to the overlapping of lenticular sheets. (Perkins)

Toellite. A biotite-hornblende-porphyrite, with garnets, that forms dikes in mica-schist and gneiss near Meran, in the Tyrol. (Kemp)

Toe nails. In geology, curved joints intersecting the sheet structure, in most cases striking with the sheets, in some differing from them in strike 45° or more. (Ries)

Toensbergite. A name [illegible] by W. C. Brögger to certain [illegible] spathic syenitic rocks, from Tönsberg, Norway, that are close relatives of the anorthosites. They differ from the anorthosites in their superior percentage of lime and lower percentage of alkalies. (Kemp)

Tofo (Durango, Mex.) China clay. (Halse)

Tofus (L.). Same as tufa. (Standard)

Toggle-joint. A joint having a central hinge like an elbow, and operated by applying the power at the junction of motion, as from horizontal to vertical, and giving enormous mechanical advantage: a mechanism common in many forms of presses, and in stone-crushers. (Standard)

Token. 1. (Aust.) A metal or leather ticket stamped with a distinctive number, fastened to a skip so as to indicate to the weighman who mined the coal (Power). A Ticket; Tag; Tally.
2. (Wales). A thin bed of coal, etc., indicating a thicker seam at no great distance. (Gresley)

Tol (Corn.). The land owner's part of the tin ore. (Pryce). Toll or rental.

Tola (Hind.). A weight for gold and silver, varying slightly according to locality, usually 180 grains Troy. (Standard)

Toll (Ches.). Royalty on rock salt, or other mineral. (Gresley)

Toller; Tollur (Corn.). One who inspects or superintends tin-bearing lands. To review or inspect. (Pryce)

Toluene. A hydrocarbon, $C_6H_5CH_3$, of the aromatic series, homologous with benzene, and obtained as a light mobile colorless liquid by distilling *tolu* balsam, and coal tar. Used in the manufacture of dyestuffs and other compounds (Webster). Formerly called Toluol.

Tolva (Sp.). 1. A hopper. 2. An ore chute. (Dwight)

Tom. An inclined trough in which gold-bearing earth or gravel is crudely washed; usually called Long tom because it is longer than a rocker. (Webster)

Tomassi process. An electrolytic process for refining lead in which the electrolyte is a solution of a double acetate of lead and of potassium or of sodium. The anodes are cast from crude argentiferous lead; the cathodes are in the form of large disks of copper or of aluminum bronze and are about half immersed in the electrolyte, in which they slowly revolve, each being placed between two anodes. The lead crystals formed are detached by scrapers. When in sufficient quantity they are collected, drained, washed, dried, and fused with a little charcoal. (Goesel)

Tombac. Any one of several copper and zinc alloys, as Prince's metal, Mannheim gold, etc. Also spelled Tambac; Tombac; Tombak. (Standard)

Tommy dodd (Aust.). A series of small pulleys, with vertical axles placed between the rails at a curve, so as to keep an endless rope in place. (Power)

Ton. 1. An avoirdupois unit of weight. A *short* or *net* ton equals 2,000 pounds (907.20 Kg.). A *long* or *gross* ton equals 2,240 pounds (1,016.6 Kg.). A *metric* ton equals 2,204.6 pounds (1,000 Kg.). A *Cornish* mining ton equals 2,352 pounds (1,066.87 Kg.).
2. A unit of internal capacity for ships; a *register* ton equals 100 cu. ft.; a *displacement* ton equals 35 cu. ft.; a *shipping* ton often reckoned at 40 cu. ft., and a ton of timber equals 42 cu. ft. (Webster)
(Aust.) A ton of firewood equals 50 cu. ft. of wood. (Davis)

Tonalite. A quartz-mica-hornblende diorite from near Meran in the Tyrol. It was named by vom Rath from Tonale, a place on Mt. Adamello. *Compare* Adamellite. (Kemp)

Tonel (Sp.). 1. A barrel; *T. de amalgamación*, an amalgamating barrel. 2. A kibble; corf. 3. A vat. (Halse)

Tonelada (Sp.). Ton. The ton of Castile equals 2,032.2 pounds avoirdupois; the Mexican and Spanish-American ton equals 2,028.88 pounds avoirdupois; the metric ton, 1,000 kg. equals 2,204.6 pounds avoirdupois. (Halse)

Tonga (Colom.). The difference in level between two points, whereby alluvial mines can be drained by a ground sluice and a lode mine by an adit. (Halse)

Tongs. 1. *See* Chain tongs; Pipe grip; Pipe tongs; Pipe wrench. (Nat. Tube Co.)
2. In gem cutting, a stand having at its upper end a vise-like arrangement by which to hold the cup in which a gem is cemented, so as to press the latter against the polishing wheel. (Standard)

Tongue. A piece of iron or steel projecting from the stem of a stamp head. (Hunt)

Tongue joint. In welding, a split joint formed by inserting a wedge-shaped piece into a corresponding split piece and welding the two together. (Century)

Tonite. An explosive consisting of about equal weights of guncotton and barium nitrate. It is used for blasting. (Webster)

Ton mile. In railroading, a standard measure of traffic, based on the rate of carriage per mile of each ton of freight. (Standard)

Tonnage. The amount of ore handled per day. The amount of ore in sight.

Tooler. A stonemason's chisel two to four inches broad (Standard). Called also Broad tool; Drove.

Tool extractor. An implement for grasping and withdrawing boring tools when broken or detached in a bore, as of an oil well, etc. Called also Tool grab. (Standard)

Tool nipper. A person whose duty it is to carry powder, drills and tools to the various levels of the mine and to bring such tools and drills as have been dulled by use to the surface. *See* Nipper, 1. (Moreno *v.* New Guadalupe Min. Co., Cal. App., 170 Pac. Rept., p. 1088)

Tool steel. Steel of superior quality, that can be highly tempered: for use in making cutting tools. (Standard)

Top. 1. A mine roof. *Top* coal, the upper part of a coal bed separated from the rest by a seam or parting. *Top* bottom (Ark.), the upper part of the bottom bench of a coal bed. (Steel)
2. A quarryman's term for overburden. (Bowles)
3. The part of a cut gem above the girdle; the crown. (Webster)
4. *See* Cap, 2; also Blue cap. (Gresley)
5. (Of a vein) *See* Apex.

Topacio (Sp.). Topaz. (Dwight)

Topaz. An aluminum fluosilicate, simplest formula, $Al_2SiO_4F_2$, but with part of the fluorine commonly replaced by the radical, OH. Used as a gem, especially when yellow (U. S. Geol. Surv.) *See* False topaz, also Oriental topaz.

Topazfels (Ger.). A brecciated, contact rock, near granite contacts, and formed of topaz, tourmaline, quartz and some rarer accessory minerals (Kemp). Also called Topazrock.

Topazolite. A variety of garnet, of topaz-yellow color, or olive-green. (Century)

Topazrock. A rock resulting from contact metamorphism, made up of an aggregate of fragments of quartz and tourmaline, cemented by a mixture of quartz and topaz (Century). Also called Topazfels.

Top bottom (Ark.) *See* Top.

Top cager. A man at the top of a shaft to superintend the operation of lowering and raising of the cage. (Illinois Third Vein Coal Co. *v.* Cioni, 215, Illinois, p. 583; Spring Valley Coal Co. *v.* Buzis, 213, Illinois, p. 341). It is also his duty, at most mines, to remove the loaded cars from the cage, and place the empty cars on the cage. *See* Cager, 1.

Top canch. That part of a mine roof which has to be taken down to give head room on roadways. (Gresley)

Top coal (Scot.). The uppermost of two or more divisions of a seam of coal. *See* Top, 1. (Barrowman)

Tope. 1. (Sp.) Top, summit or apex.
2. (Colom.) A discovery of ore. (Halse)

Top gas (Aust.). Fire damp. (Power)

Top head (So. Staff.). A passage driven in the upper part of a thick coal seam for drawing off the gas (Gresley). *See also* Boss.

Topholes (Eng.). Working places extending to the full rise. (Redmayne)

Tophus. Any natural calcareous tufa. Called also Toph; Tophin. (Standard)

Topit (Eng.). A small bracehead, screwed on to the top of boring rods when withdrawing them from the hole. (Gresley)

Top kick. *See* Top shot.

Topman. Any man employed on the surface about a mine. (Power)

Topographic adolescence. A geologic stage when lakes have mostly disappeared, and river drainage is well established, stream channels being comparatively narrow and well marked and falls occurring characteristically (Standard)

Topographic high. Frequently used in the oil fields to indicate the higher elevations, regardless of age; opposed to topographic low which indicates a lower elevation. *Compare* Geologic high.

Topographic infancy. In geology, a featureless stage characterized by a smooth nearly level surface of deposit, lakes abounding in slight depressions, shallow streams, and drainage-systems not well established. (Standard)

Topographic low. *See* Topographic high.

Topographic maturity. In geology, a stage of maximum diversity of form when valleys have greatly increased, and the river channels are widely opened. (Standard)

Topographic old age. A geologic stage in which there is a featureless surface, differing from the earliest stage (topographic infancy) in having a system of drainage streams, separated by faintly swelling hills. (Standard)

Topography. 1. The science of surveying the physical features of a district or region and the art of delineating them on maps. 2. The physical features of a district or region, such as are represented on maps, taken collectively; especially, the relief and contour of the land. (La Forge)

Topping. The coal on a mine car above the top of the car box. (C. and M. M. P.)

Topple (So. Wales). From Tophole. A working place driven to the rise of the main levels. (Gresley)

Top ply; Top leaf; Tops (Scot.). The uppermost layer of a bed of coal left for a roof (Gresley). Also called Water leaf. *See also* Top, 1.

Top rod (Scot.). The rod connecting the uppermost pump rod to the bell-crank. (Barrowman)

Top-set beds. The material laid down in horizontal layers on top of a delta. *See* Fore-set beds and Bottom-set beds. (Watson, p. 274)

Top shot. An explosion or puff of gas at the furnace top. (Willcox)

Top slicing. A method of stoping by which the ore is taken from horizontal stopes and supporting the overlying mat with timber. (H. C. Hoover, p. 123)

Top slicing and caving. *See* Top slicing and cover caving.

Top slicing and cover caving. The important feature is the working of the ore body from the top down in successive horizontal slices that may follow one another sequentially or simultaneously. The whole thickness of the slice is worked. The ore may be broken by overhand or underhand stoping in each unit. The overburden or cover is caved after mining a unit. The method is a retreating method. The long-wall method, the pillar robbing in both room-and-pillar, and bord-and-pillar methods of mining coal are essentially the same in principle as top slicing. The principal difference is that a single slice only is worked in these methods. There are two modifications: top slicing by drifts, and top slicing by rooms. A timber mat is used in almost all cases (Young). Other terms used for this system are: Caving system; Crosscut method (combined with removal of pillars); Horizontal slicing (descending); Mining ore from top down; Panel slicing; Prop slicing; Removing pillars and allowing roof to cave; Slicing under mats of timber in panels; Square-set slicing; Top slicing and caving; and Transverse slicing with caving.

Top slicing combined with ore caving. In this method the ore body is worked from the top down in successive slices. Instead of taking the full height of the slices, only the lower part is taken and the upper part is caved. After removing this portion of the ore, the cover is caved. A timber mat is used in most cases to separate the broken cover from the ore and for safety (Young). Also known as Caving system; Sub-drifting and caving; Subslicing; Slicing under ore with back cave; Sublevel caving, and Sublevel slicing.

Top wall. Same as Hanging wall. (Standard)

Top water. Water which enters an oil or gas well from a sand above the productive sand. *Compare* Bottom water; Edge water. (U. S. Geol. Surv. Bull. 658, p. 44)

Tor (Eng.). A rounded mass of rock left in an elevated position by the decay of surrounding parts. Sometimes called Bowlder (Duryee). A rocky pinacle; a high pointed hill. (Webster)

Torbane Hill mineral. A boghead coal obtained from Torbane Hill, Scotland. (Webster)

Torbanite. A dark brown variety of cannel coal (Power). A boghead coal from Torbane Hill, Scotland (Webster). Also called Bathvillete.

Torbernite. A hydrous phosphate of uranium and copper, $CuO.2UO_3.P_2O_5.8H_2O$ (U. S. Geol. Surv.)

Torbite (Lanc.). A trade-mark name of a dried and compressed peat. (Century)

Torch. An oil-burning, wick-fed lamp of tin or copper, with a long spout, used by miners.

Tordrillite. A name based on the Tordrilla mountains, Alaska, and suggested by J. E. Spurr for porphyritic varieties of alaskite, which have a finely crystalline or aphanitic groundmass. *See also* Alaskite. (Kemp)

Tormentor (Aust.). A wooden axle studded with iron spikes, and turned round in a trough, for the purpose of puddling auriferous clay (Davies). A device somewhat similar to the log washer.

Tormo (Sp.). A high pointed, isolated rock. (Halse)

Tornapunta (Sp.). 1. An inclined stay or prop which supports two parallel timbers. 2. An inclined stull. (Halse)

Tornero (Sp.). 1. Windlass-man, or man at the winch or *torno;* 2. Turner of a lathe. (Halse)

Torno (Sp.). 1. A windlass; *T. con accion directa*, a direct-acting hoist; *T. con malacate*, a whim; *T. con piñones*, a geared hoist; *T. de mano*, a hand winch; *T. de vapor*, a steam winch or hoist; 2. A turning lathe. 3. (Spain) A sump. (Halse)

Toro. 1. (Sp.). A bull. 2. (Mex.) Fire damp. (Halse)

Torpedo. 1. An explosive cartridge, or shell, lowered or dropped into a bored oil well, and there exploded, to clear the well of obstructions, or to open communications with a source of supply of oil. 2. A kind of detonating cartridge placed on a rail, and exploded when crushed under a locomotive wheel; used as a signal. (Webster)

Torrefaccion (Sp.). Calcination. (Lucas)

Torrents. Beds of quicksand encountered below the chalk marl in the Anzin coal field, in France. (Gresley)

Torta (Mex.). The flat circular heap of ore spread out on the floor of the patio in a cake about fifty feet in diameter and a few inches in thickness, ready for amalgamation in the *patio* process (Duryee). *T. rendida*, amalgam ready to be washed. (Halse)

Tosa (Mex.). The grinding space in the arrastre. (Egleston)

Tosca (Mex.). 1. Clayey vein matter. 2. Talc seam. 3. Soft, decomposed porphyry. 4. (Pat.) A white calcareous marl. 5. (Colom.) In alluvial mining, a bed of volcanic origin, as lava, tufa, etc. (Halse)

Toscanite. A name proposed by H. S. Washington for a group of acid, effusive rocks in Tuscany (Italian, Toscana) and elsewhere, which are characterized mineralogically by the presence of basic plagioclase, as well as orthoclase, and by occasional quartz. They range from 62–73 silica and are intermediate between rhyolites and dacites. *Compare* Dellenite. (Kemp)

Toss. *See* Tossing.

Tossing; Tozing (Corn.). 1. Washing ores by violent agitation in water, their subsidence being accelerated by packing or striking, with a hammer, the keeve in which the operation is performed. Chimming is a similar process on a smaller scale. 2. Refining tin by allowing it, while molten, to fall several feet through the air. (Raymond)
3. Jigging. (Webster)

Tostado (Sp.). Roast; *T. ó muerte*, a dead roast; *Mineral tostado*, roasted ore. (Lucas)

Tostador (Mex.). 1. A roasting furnace. 2. A man in charge of the furnace. (Halse)

Tostar (Sp.). To roast. (Dwight)

Tot (No. of Eng.). A measure of gunpowder used in blasting. (Gresley)

Totuma (Sp. Am.). A large dish made of a gourd and used in gold washing. (Halse)

Touch. 1. (Eng.). A fuse for setting off a powder charge. (Gresley)
2. *See* Touchstone. 3. A stone of durable character suitable for preserving inscriptions or for fine monumental work. (Century)

Touch needle. A needle or small strip of gold alloy, of known composition, for determining the composition of another alloy by comparing marks made by each on the same touchstone. (Standard)

Touchstone. 1. A black siliceous stone, allied to flint, SiO_2. (Dana)
2. A black, hard stone (basalt or jasper), on which the fineness of an alloy of gold and silver can be tested by comparing its streak with that of a piece of alloy (touch-needle) of known fineness (Raymond). Also called Lydian stone and Basanite.

Tough. 1. Having the quality of flexibility without brittleness; yielding to force without breaking. 2. The exact state or quality of texture and consistency of well-reduced and refined copper. 3. Copper of the above quality; called also Tough cake. (Webster)
4. (Shrop.) Gray, plastic clay. (Gresley)

Tough cake. Refined or commercial copper (Raymond). *See also* Tough, 2 and 3.

Toughen. To remove the last remaining quantities of foreign metals from (copper) in refining, as by poling. (Standard)

Tough pitch. A term used in electrolytic copper refining to designate copper which has set, from the molten condition, with a level sur-

face. (Eng. and Min. Jour., vol. 102, p. 875). *See* Underpoled and Overpoled.

Tour (Calif.). A term used in oil-well drilling which means the same as "shift" in other mining operations (A. Rundell *v.* American Oil Fields Co., 160 Pacific, p. 161, 1916). Also spelled Tower.

Tourmaline. A complex aluminum silicate of hexagonal crystallization containing boron and in some varieties lithium and other elements. Of various colors; the clear pink, blue, and green varieties are used as gems (U. S. Geol. Surv.). It occurs in long, usually striated prisms in the ancient crystalline rocks. Called also Schorl.

Tournasin (Fr.). A knife for scraping excess of slip from baked and decorated ceramic ware. (Standard)

Tournette (Fr.). In ceramics, a rotating tablet, resembling a small potter's wheel, used in decorating the finer wares with lines. (Standard)

Tourniquet (Fr.). A device for stopping the flow of blood by means of compression of the blood vessel, as an artery or vein, on the side of the wound from which the blood is flowing. It consists, usually, of a pad over the blood vessel pressed down by a strap, rubber band, twisted bandage, or the like.

Tout venant (Belg.). Coal as landed on the bank previous to screening and sorting (Gresley). Run of mine.

Tow. 1. (Leic.) Dark, tough, earth clay or shale. (Gresley)
2. (Scot.) The winding rope, which before the introduction of iron or steel ropes was made of hemp or tow. (Barrowman)

Tower (Calif.). *See* Tour.

Township. In surveys of the public lands of the United States, a division of territory that is, with certain exceptions, six miles long on its south and east and west boundaries which follow meridians, and so slightly less than six miles on the north. It contains 36 sections. (Webster)

Towt (Newc.). A piece of old rope. (Raymond)

Tozing. *See* Tossing.

Trabajadores. 1. (Colom.) Mineral veins that have been worked open cast (Halse). 2. Workmen; laborers.

Trabajar (Sp.). To work a mine. (Halse)

Trabajo (Sp.) 1. Work. 2. Mine working. *T. de arranque*, a working place; *T. de banca*, underhand stoping, overhand stoping, back stoping, roof work; *T. del antiguo* (Colom.), ancient mine workings, or those worked during the time of the Spanish *conquistadores; T. del indio* (Colom.), mines prior to the conquest. (Halse)

Trace. 1. The intersection of a line or plane with a plane or other surface. 2. A very small quantity of a constituent, especially when not quantitatively determined, owing to its minuteness; in assaying, often abbreviated *tr.* (Webster)
3. To follow the lode on the surface, and to lay it open by long pits. (Davies)

Tracheo (Sp.). Passing ore or waste from one *peón* to another in baskets. (Halse)

Trachorheite. A name proposed by F. M. Endlich as a collective designation for the four rocks, propylite, andesite, trachyte, and rhyolite, as used by von Richthofen. (Kemp)

Trachy-andesite. Effusive rocks, intermediate between trachytes and andesites. Used by H. S. Washington for trachytes which have also much acidic plagioclase (andesine to oligoclase). (Kemp)

Trachy-dolerite. A name suggested by Abich for a group of rocks intermediate between the trachytes and basalts. *Compare* Latite. Trachydolerite as used by H. S. Washington means a trachyte with considerable basic plagioclase (labradorite to anorthite). (Kemp)

Trachyte. Any aphanitic, aphanophyric, or glassy igneous rock composed essentially of alkalic feldspar, with or without mica, amphibole, pyroxene, and other accessories, or of rock glass having essentially the same composition. (La Forge) It was formerly used for both rhyolite and trachyte proper, as a field term for light-colored lavas and porphyries. As such in older reports it is to be understood. *Compare* Acmite-trachytes and Pantellerites. (Kemp)

Trachytic. 1. Characteristic of, pertaining to, formed of, occurring in, or resembling trachyte. 2. Specifically, characterized by closely packed small laths or prisms of alkalic feldspar lying roughly parallel and arranged in lines resembling lines of flow, forming the trachytic fabric. (La Forge)

Trachytic texture. A special name for those microscopic groundmasses that are made up of rods of feldspar, usually in flow-lines, but without basis. (Kemp)

Track (Aust.) A Bendigo term applied to veins when the walls come together; when followed the veins widen out again. (Power)

Track-channeler. In quarrying, a rock-channeler designed to operate from a track on which it is mounted; frequently a combined locomotive and channeling-machine. (Standard)

Tracking. Iron or wooden tram rails.

Track layer; Trackman. In railroading, any workman engaged in work involved in putting the track in place (Webster). Also one employed at mines to lay or repair track.

Traction. The act or method of drawing, or the state of being drawn; particularly the act of drawing by motive power over or along a surface, as in towing a load or pulling a wagon or car. (Standard)

Traction rope. A rope used for transmitting the power in a wire-rope tramway and to which the buckets are attached. (C. M. P.)

Trade. 1. (Eng.) Refuse; débris. (Bainbridge)
2. Demand for coal. (Min. Jour.)

Tragante. (Sp.). 1. A sluice; a ditch. 2. A chimney. 3. The mouth of a shaft furnace. 4. In a reverberatory furnace, the inclined flue leading to the chimney. (Halse)

Trail. 1. A footpath or track worn by passage through a wilderness or wild region. (Webster)
2. *See* Trail of the fault.

Trailer. 1. (Scot.) A bar dragging behind a car to prevent it from running down grade should a coupling break; a jock. 2. (No. of Eng.) One who pushes a coal car in a mine; a putter.

Trailer cable (Aust.). A branch cable for conveying electricity to a coal-cutter, one end of which is attached to the main cable. It is capable of being paid out as the machine advances (Power). Also used on gathering motors, as the trolley wire does not extend into the rooms.

Trail of the fault. Crushed material of a bed or vein that indicates the direction of the fault movement; valuable as a guide to the miner in search of the main vein.

Train. 1. To trace, or follow an alluvial mineral deposit to its place of origin. 2. A roll train. 3. A connected line of cars on a railroad, with or without a locomotive. 4. A line of gunpowder laid to lead fire to a charge. 5. (Can.) A long sleigh for transportation of merchandise. 6. A trip of coal cars; *see* Journey, 1.

Train boats (York.). A number of boats coupled together in a simple manner, admitting of free articulation, in which coal is carried on canals or rivers from the mines to the shipping ports. (Gresley)

Train boy. A boy who rides on a trip, to attend to rope attachments, or to signal in case of derailment of cars, etc. A trip rider. (C. and M. M. P.)

Train mile. One mile traveled by one train; used as a unit of railroad operation in order to estimate economy in running expenses. (Webster)

Trainroad. A temporary track in a mine, used for light loads (Century). A tramroad.

Tram (Wales). 1. A four-wheeled truck to carry a tub, corve, or hutch. 2. The rails of a tramroad or railroad (Raymond). *See* Tramroad. 3. A boxlike wagon, now often of steel, running on a tramway or railway in a mine, for conveying coal or ore. (Webster)
4. To haul or push trams or cars about in a mine (Gresley)

Tramcar (Eng.). A car used in coal mines; same as Tram, 3. (Century)

Tram carriage (Corn.). *See* Tram, 1.

Trammer. 1. One who pushes cars along the track. In Arkansas known as a pusher (Steel). Also Haulier, and Putter.

2. (Mich.) A person whose duty it is to load broken rock upon tram cars and deliver it at the shaft. (Meola *v.* Quincy Mining Co., 140 N. W. Rept., p. 460; Mesich *v.* Tamarack Mining Co., 151 N. W. Rept., p. 565)

Tramo (Sp.) 1. Piece; *T. rico*, a rich ore shoot. 2. The portion of the timbering in a shaft that sustains the walls. 3. A ladder way. (Halse)

Trampa (Sp.). 1. A sluice gate. 2. A mercury trap. (Halse)

Trampilla (Sp.). The trap door of an ore chute. (Halse)

Tramp iron. Stray pieces of drill steel, picks, tools, etc. which are found in ore. Often removed by a magnet as ore is fed into a crusher.

Tram plate (Scot.). A cast-iron flanged rail or plate for tram roads. (Barrowman). *Compare* Tram rail.

Tram rail (Eng.). A rail for a tram or trams (Webster). A light railroad rail distinguished from tramplate by being rolled while the latter is cast.

Tramroad (Eng.). A road laid with tram rails or plates. So called after one Benjamin Outram, of Little Eton, in Derbyshire, who in 1800 used stones for carrying the ends of the metal plates or edge rails. The name Outram was subsequently contracted into *Tram*, hence tramway, trams, etc. (Gresley)

Tram rope. A hauling rope, to which the cars are attached by a clip or chain, either singly or in trips. (C. and M. M. P.)

Tramway. 1. A roadway having plates or rails on which wheeled vehicles may run. A *tramroad*. (Standard)
2. A suspended cable-system along which material, as ore or rock, is transported in suspended buckets. *See* Aerial tramway.

Tranca (Mex.). Square set of timbers. (Dwight)

Transcurrent fault. *See* Fault.

Transfer car. A quarry car provided with transverse tracks, on which the gang car may be conveyed to or from the saw gang (Bowles). *See also* Transfer carriage.

Transfer-car man. One who operates an electric car on an ore trestle, which transfers ore from the ore bridge to an ore bin. (Willcox)

Transfer carriage. A platform or truck used to transfer mine cars. (Chance)

Transfer gilding. In ceramics, a transfer of a pattern in gold, as from paper to unglazed ware, usually done either by direct transfer of the gold in reverse, or by stamping the pattern in oil and dusting with gold powder. (Standard)

Transformer. An apparatus for transforming an electric current from a high to a low potential (step-down transformer) or vice versa (step-up transformer) without changing the current energy; a converter. (Webster)

Transformer oil. An oil for high tension electrical transformers free from water and mineral acids. It should show little or no volatility at 100° C. Those machine oils, derived from petroleum, which have a flash point of over 160° C. (open test), with a volatility of less than 0.1 per cent in five hours at 100° C., are usually suitable for use in transformers. (Bacon)

Transgression. In geology, discrepancy in the boundary-lines of continuous parallel strata; unconformability of overlap; used only by European geologists. (Standard)

Transit. A surveying instrument with the telescope mounted so that it can be transited; called also a Transit theodolite.

Tansition. Intermediate. In the nomenclature of Werner and other early geologists, the older Paleozoic strata, which are now assigned to the Cambrian, Ordovician, and Silurian systems. But little used at present.

Tansition point. In physical chemistry, a single point at which different phases are capable of existing together in equilibrium. (Webster)

Transition rocks. *See* Transition.

Translatory fault. *See* Fault.

Translucent. Admitting the passage of light, as milk-quartz, but not capable of being seen through. (Roy. Com.)

Transmission rope. A rope used for transmitting power. (C. M. P.)

Transmutation. An alternating change. The conversion of metals, one into another, especially, base metals into gold or silver, which was one of the aims of alchemy, but never realized.

Transmutation glaze. In ceramics, an iridescent porcelain glaze. (Standard)

Transparent. That may be seen through, as rock crystal, Iceland-spar, selenite, etc. (Roy. Com.)

Transportar (Sp.). To transport, convey, or haul. (Halse)

Transportation. 1. In geology, the shifting of material from one place to another on the earth's surface by moving water, ice, or air. The carriage of mud and dissolved salts by rivers, the passage of a dust-laden whirlwind across a desert, the inland march of sand dunes from a seashore, and the creeping movement of rocks on a glacier are all examples of transportation. (Ransome)
2. The hauling, or moving from one place to another, of material, as ore, coal, rock, etc.

Transporte (Sp.). Transport, haulage, or conveyance; *T. aérco*, a wire-rope tramway; *T. con trincos*, transport by sledges; *T. subterráneo*, underground haulage, tramming. (Halse)

Transverse fault. A fault whose strike is transverse to the general structure. (Lindgren, p. 121)

Transverse lamination. Lamination of cleavage transverse to stratification. (Standard) *See* Cross-bedding.

Transverse slicing with caving. *See* Cover caving; Top slicing.

Transverse strength. A measure of the capability of a bar of stone (or beam) supported at its ends, to bear a weight or load at its center. (Bowles)

Transverse with filling. *See* Overhand stoping.

Tranvía (Mex.). Tramway. (Dwight)

Trap. 1. Trap rock. A general name for dark fine-grained igneous rocks, particularly lavas or dikes. *See also* Basalt and Diabase. (U. S. Geol. Surv.) A useful field name for any dark, finely crystalline, igneous rock. It is a Swedish name from the occurrence of such rocks in sheets that resemble steps, "trapper" (Kemp). *Compare* Whin, 1.
2. A door used for cutting off a ventilating current, which is occasionally opened for haulage or passage; guarded by a trapper. (Raymond)
3. A fault or dislocation. 4. (Scot.) Traveling road for miners in Edge coals driven on the slope of the seam. (Gresley)
5. (or Well) The troughs and catch-pits, whether carrying mercury or not, which are used to arrest escaping amalgam, etc. The word "trap" should be confined to the deep boxes unprovided with mercury, and the word "well" to the transverse troughs which do contain it. At Clunes the word "boxes" is used, while, elsewhere in Australia "ripples" is a term given to shallow wells as distinguished from the deep ones. (Raymond)
6. (Scot.) Short ladders in a shaft. (Barrowman)

Trap brilliant. A trap-cut brilliant (Standard). *See* Trap cut.

Trap cut. A gem with a row or rows of step-like facets around the table and culet (or small lower terminus of the gem, parallel to the table), or around the culet alone. (Standard)

Trap dike. A dike of any of the sorts of rock called trap. The term has no very definite significance, as rocks such as bostonite and dacite have been included under it. (La Forge)

Trap door. A door in a mine passage to regulate or direct the ventilating current. Also called Weather door. *See also* Trap, 2.

Trap-down (Brist.). A down-throw fault. (Gresley)

Trapezohedron. 1. In the isometric system, the same as Tetragonal trisoctahedron, *which see*. 2. In the tetragonal and hexagonal systems, any of several forms having principal and lateral axes of symmetry, but no planes of symmetry, and enclosed by six, eight, or twelve faces each having unequal intercepts on all the axes. (La Forge)

Trapiche (Chile). A primitive form of grinding mill (Dwight). Especially of the Chilean or edge runner type.

Trapichero (Chile). The man in charge of a *trapiche*. (Halse)

Trappean. Relating to trap rocks. (Hitchcock)

Trappean ash. A fragmentary, scoriaceous variety of eruptive rock. Called also Ash-bed, though generally resembling volcanic deposits only in structure, not in origin. (Standard) Obsolete.

Trapper. 1. A person employed in an entry to open and close a door for the cars (Sprinkle *v.* Big Sandy Coal & Coke Co., 78 S. E. Rept., p. 972; National Fuel Co. *v.* Maccia, 25 Colorado App., p. 446). Also called Trapper boy; Nipper; Door tender.

Trappoid. Of, pertaining to, or having the nature of trap rock. (Standard)

Trap rock. *See* Trap, 1.

Trap-up (Brist.). An up-throw fault. (Gresley)

Trasera (Sp.). The back of a furnace. (Halse)

Traspalar (Mex.). To shovel. To turn the *torta* in the *patio* process with a shovel. (Halse)

Trass (Ger.). A gray, yellow, or whitish earth, related to pozzuolana, common in volcanic districts, formed by the decomposition of trachytic cinders, and consolidated by infiltration of calcareous or siliceous solutions; used in preparation of a hydraulic cement. Formerly called Tarrace; Tarras; Terrace; Terras. (Standard)

Tratamiento (Sp.). Treatment. *See* Beneficio, 3. (Halse)

Traunter (Mid.). A long sprag. Also called Tront. (Gresley)

Travel (Scot.). The length of stroke of a pump. (Barrowman)

Traveler. 1. A truck rolling along a suspended rope for supporting a load to be transported. (C. M. P.) 2. A crab or winch moving on an elevated track, used especially in erecting steel bridges or other large work; also a traveling crane. (Webster)

Traveling apron. *See* Apron, 6.

Traveling belt. A conveyor belt, for handling ore, rock, or coal.

Traveling road (Eng.). An underground passage or way used expressly, though not always exclusively, for men to travel along to and from their working places (Gresley). A traveling way.

Traveling way. *See* Traveling road.

Traveling weight (Aust.). *See* Underweight.

Traveled. In geology, removed from the original place; erratic (Standard). Said of stones, bowlders, etc.

Traverse. 1. To make a traverse survey. 2. A line surveyed across a plot of ground. 3. An oblique line or streak; a vein or fissure, as in a rock running transversely. (Webster)

Traverse survey. A survey in which a series of lines joined end to end are completely determined as to length and azimuth, these lines being often used as a basis for triangulation; used for long narrow strips of country, as for railroads (Webster). Also used for underground surveys.

Travertine. Calcium, carbonate $CaCO_3$, deposited from solution in ground and surface waters. The cellular deposits are known as tufa, calcareous sinter, spring deposit, or cave deposit. When solid, banded, and susceptible of a good polish, it is known as Mexican onyx, or onyx marble. True onyx, however, is banded silica or agate. Travertine forms the stalactites and stalagmites of caves, and the filling of some veins and spring conduits. (U. S. Geol. Surv.).

Travertino (Mex.). Travertine. (Dwight)

Travesaño (Sp.). A cap piece; a strut. (Lucas)

Traviesa (Sp.). 1. A crosscut or cross gallery, usually at right angles with the main gallery. 2. A bearing beam; sleeper; a dividing piece. (Halse)

Trawley. A small truck or car conveying material about a furnace or iron mill: sometimes applied to trucks, in mines, etc. (Standard). *See* Trolley, 1.

Trawn (Corn.). In mining, a cross-course. (Standard)

Trazador (Mex.). An underground foreman. (Halse)

Tread. The pit in which brickmakers soak their clay before putting it into the pug mill. (Standard)

Treasure Box. A pocket of very rich ore.

Treatment. In metallurgy, the reduction of ores by any process whereby the valuable constituent is recovered.

Treble coursing. In mining, the system of dividing a ventilating current into three coursings (splits). (Standard)

Tree. 1. A thick log used as a prop in heavy ground (Steel). A prop, leg, or puncheon.
2. In chemistry, a treelike aggregation of crystals, as a lead tree obtained by suspending a piece of zinc in a solution of lead acetate. (Webster)
3. (Scot.) A trestle. 4. The fulcrum for the lever used in boring. (Barrowman)

Tree agate. A variety of agate containing dendritic markings; sometimes made artificially. (Standard)

Treed. Supported by props, as a mine roof. (Barrowman). *See* Tree, 1.

Treenail. A long wooden pin for securing planks or beams together. (C. and M. M. P.)

Tree-up (Scot.). To set props in the workings. (Gresley)

Trek (So. Afr.). The act of drawing or hauling; traction; also, the state of the roads; as, the *trek* was heavy. (Standard)

Trek wagon (So. Afr.). A large six-wheeled covered wagon used in trekking. (Webster)

Treloob (Corn.). To treat or work loobs or tin-slimes; to toss. An obsolete term. (Standard)

Treloobing (Corn.). Stirring the "loobs" (slime tin) in water, so that the lighter mud may run off. (Davies)

Tremblores (So. Am.). Tremors of the earth's surface in volcanic districts. (Standard)

Tremie. A box or frame of wood or metal used for depositing concrete under water. Its upper section forms a hopper above water to receive the concrete, and it may be moved laterally or vertically by any suitable device, as a traveling crane. (Standard)

Tremolite. White fibrous amphibole, $CaMg_3Si_4O_{12}$. (U. S. Geol. Surv.)

Tremolitic. Pertaining to or characterized by the prerence of tremolite, as tremolitic marble. (Century)

Trend. 1. The direction or bearing of the outcrop of a bed, dike, sill, or the like, or of the intersection of the plane of a bed, dike, joint, fault, or other structural feature with the surface of the ground. 2. The direction or bearing of a fold or series of folds in rocks, or of the axes of the folds, or of topographic features that are consequent on the geologic structure. (As used in either sense the *trend* may or may not coincide with the *strike*, depending on the structural relations at the place of observation.) (La Forge)

Trent agitator. An agitator with arms of the paddle-wheel type, but they are hollow, and the pulp solution, or air, is discharged from nozzles on these arms, thus causing the stirrer to rotate. (Liddell)

Trenton. Of, pertaining to, or designating a division of the North American Silurian formation, highly developed in the Appalachian region and in the interior. (Standard)

Trépan (Fr.) A heavy tool, having vertical chisels fixed to a horizontal bar, used in boring shafts at a single operation (Webster). A boring machine used for shaft sinking through water-bearing strata. (Skinner)

Trestle man. One who unloads coke, limestone, and ore, and keeps bins poked down. (Willcox)

Triad. In chemistry, an atom, radical, or element that has a combining power of three. (Standard)

Trial. In ceramics, one of the pieces of ware which is used to try the heat of the kiln and the progress of the firing of its contents. (Century)

Triamorph. Minerals having the same chemical composition, but crystallizing in three different forms, *e. g.*, quartz (rhombohedral), tridymite (hexagonal), and asmanite (rhombic). (Power)

Triangle. 1. (Scot.) A three-legged derrick for hoisting rods in boring. (Barrowman)
2. In ceramics, a triangular stilt. (Webster)

Triangulate. To divide into triangles; to survey by triangulation; having triangular markings. (Webster)

Triangulation. 1. In surveying, the series of network of triangles into which any portion of the earth's surface is divided in a trigonometrical survey. 2. The operation of measuring the elements necessary to determine these triangles, and thus to fix the positions and distances apart of their vertices (Webster). *See* Trigonometrical survey.

Triassic. The earliest of the three geologic periods comprised in the Mesozoic era, in the nomenclature generally used. Also the system of strata deposited during that period. (La Forge)

Tribolites. A term employed by M. E. Wadsworth to include mineral abrasives or attrition materials. (Power)

Triboluminescence. The property of some specimens of zinc sulphide of emitting sparks when scratched. Not only the mineral zinc-blende but the artificial sulphide exhibits this phenomenon. The sparks do not ignite inflammable gases. (Min. and Sci. Press, May 1, 1915)

Tribunal de minería (Sp.). Mining tribunal. (Hanks)

Tribute (Corn.). A portion of ore given to the miner for his labor. Tributors are miners working under contract, to be paid by a tribute of ore or its equivalent price, the basis of the remuneration being the amount of clean ore contained in the crude product. (Raymond)

Tribute pitches (Eng.). The limits assigned to a crew of miners. (Bainbridge)

Tributer. One who works a mine or mineral deposit for a share of the product. (Roy. Com.)

Tribute work. In mining, work on shares. (Standard)

Trichite. A microscopic hair-like crystallite. (Kemp)

Trichroism. A property possessed by certain minerals of exhibiting three different colors when viewed in different directions. (Power)

Triclinic block. In quarrying, a term applied to a block of stone bounded by 3 pairs of parallel faces, none of the interfacial angles being right angles. (Bowles)

Triclinic system. That system of crystals in which the forms are referred to three unequal mutually oblique axes. (La Forge)

Tridymite. A mineral consisting, like quartz, of silica, SiO_2, but differing in crystallization. (Dana)

Trig (Eng.). A sprag used to block or to stop a tram wheel, or any machinery. (C. and M. M. P.)

Triger process (Fr.). A method of sinking through water-bearing ground, in which the shaft is lined with tubbing and provided with an air lock, work being conducted under air pressure. *Compare* Kind-Chaudron process. (Webster)

Trigonal. 1. Having, in the ideal or symmetrically developed form, triangular faces: as the trigonal trisoctahedron. 2. Threefold; occurring three times at equal intervals in one complete rotation: said of one kind of axial symmetry. 3. Characteristic of, pertaining to, or belonging in the trigonal division of the hexagonal system. (La Forge)

Trigonal system. According to some crystallographers, the trigonal (or rhombohedral) division of the hexagonal system, regarded as a system by itself. (La Forge)

Trigonometrical survey. A survey accomplished by the trigonometrical calculation of lines after careful measurement of a base line and of the angles made with this line by the lines toward points of observation; generally preliminary to a topographical survey (Standard). *See* Triangulation.

Trilla (Mex.). 1. A heap of ore. 2. A heap of slimes on the *patio*. (Halse)

Trilling. A compound crystal consisting of three individuals. (Webster)

Trimerite. A rare mineral consisting of the silicates of beryllium, manganese and calcium. (Century)

Trimetric. In crystallography, same as orthorhombic. (Standard)

Trimmer. 1. (Eng.). A piece of bent wire by which the size of the flame of a safety lamp is regulated without removing the top of the lamp. *See* Pricker. 2. (No. of Eng., So. Wales) One who arranges coal in the hold of a vessel (collier, ship) as the coal is discharged into it from bins. (Gresley)
3. The person who sorts the coal in the railway cars after it is dumped into them. (Roy)
4. (Scot.) One who cleans miners' lamps. (Barrowman)

5. In coal storage, an apparatus used for piling coal in gradually increasing piles made by building up at the point of the cone or top of the prism. (Webster)

Trimorphism. In crystallography, the property of crystallizing in three fundamentally different forms of the same chemical composition. (Standard)

Trincha (Mex.). 1. Piled waste used for walling levels. 2. A coke fork. (Halse)

Trinchera (Mex.). A roughly-stacked pile of rock or ore. (Dwight)

Trincho (Colom.). 1. A trench. 2. A dam of wood, earth and stone. (Halse)

Trinkerite. A red to brown mineral resembling tasmanite in composition, found in brown coal in Istria and Styria; it has a specific gravity of 1.025, fuses at 168° to 180° C., and is soluble in hot benzol. (Bacon)

Trinidad pitch. Trinidad asphalt. The deposit of solid or semi-solid bitumen constituting the Pitch Lake of Trinidad. (Bacon)

Trip. 1. The cars hauled at one time by mules, or by any motor, or run at one time on a slope, plane, or sprag road. A train of mine cars. (Steel). 2. An automatic arrangement for dumping cars; a tipper; a kickup.

Tripestone. A contorted concretionary variety of anhydrite. (Power)

Trip hammer. A massive tilt hammer, in which the lever is raised by wipers. Used especially for shingling. (Webster)

Triphane. In mineralogy, same as Spodumene. (Standard)

Triphylite. *See* Lithiophilite.

Triple-entry. A system of opening a mine by driving three parallel entries for the main entries. (Steel)

Triple-entry room-and-pillar mining. *See* Room-and-pillar method.

Triplet (No. of Eng.). A tipper; a kickup (Gresley). *See* Trip, 2.

Triplite. A fluophosphate of iron and manganese principally, containing also calcium and magnesium. Dark brown, and monoclinic. (Webster)

Tripod drill. A reciprocating rock drill mounted on three legs and driven by steam or compressed air. The drill steel is removed and a longer drill inserted about every two feet. (Bowles)

Tripoli; Tripolite. An incoherent, highly siliceous sedimentary rock composed of the shells of diatoms or of radiolaria, or of finely disintegrated chert. (La Forge) Used as a polishing powder and for filters. Called also Polierschiefer; Rottenstone, Terra cariosa. (Standard)

Tripoline. Of or pertaining to tripoli. (Century)

Tripolite. An opal-silica, composed of the siliceous shells of diatoms. *See* Tripoli.

Tripper. 1. One who trips. 2. A tripping device or mechanism, as a device for causing the load on a conveyor to be discharged into a hopper, bin, etc.; a trip (Webster). An automatic car dump.

Trip rider. One who rides on trips and whose duty it is to throw switches, give signals, make couplings, etc. Also called Rope rider.

Trisoctahedron. In the isometric system, either of two forms of normal symmetry, enclosed by 24 faces: (*a*) the trigonal or ordinary trisoctahedron, having triangular faces, each with equal intercepts on two axes and a greater intercept on the third axis; (*b*) the tetragonal trisoctahedron (also called trapezohedron and icositetrahedron), having trapezial faces, each with equal intercepts on two axes and a less intercept on the third axis. (La Forge)

Tristetrahedron. In the isometric system, either of two forms of *tetrahedral* symmetry, enclosed by 12 faces: (*a*) the trigonal tristetrahedron or trigondodecahedron, having triangular faces, each with equal intercepts on two axes and a less intercept on the third axis; (*b*) the tetragonal tristetrahedron or deltoid dodecahedron, having trapezial faces, each with equal intercepts on two axes and a greater intercept on the third axis. (La Forge)

Trituradora (Sp.). Rock breaker or crushing machine. (Halse)

Triturar (Mex.). To crush or break ore; *T. con cilindros*, to crush with rolls. (Halse)

Trituration. The act of triturating or reducing to a fine powder by grinding. It is a dry process, and thus distinguished from *levigation*. (Century)

Triumph concentrator. A machine resembling a Frue vanner (*which see*), but the shaking motion is endwise instead of side to side. (Liddell)

Trivalent. In chemistry, having a valence or combining power of three. (Standard)

Trocar. 1. (Sp.) To exchange. 2. (Colom.) To pass *bateas* full of gravel and earth from hand to hand, the *peons* standing in line. (Halse)

Trocha (Sp.). A path cut through forests, especially for surveying purposes. (Halse)

Troctolite. A variety of gabbro composed essentially of feldspar and olivine, the pyroxene being subordinate. (La Forge) *Compare* Ossipyte.

Trod (Eng.). A track, road or pathway. (Webster)

Trogue. (Eng.). A wooden trough, forming a drain. (Raymond)

Troil (Corn.). A tin miner's feast. Called also a Duggle. (Pryce)

Troilite. Ferrous sulphide, FeS, occurring in nodular masses and in thin veins in many iron meteorites. By some authors regarded as identical with pyrrhotite. (Dana)

Troje. 1. (Sp.) A granary. 2. *T. de metal* (Guerrero, Mex.), deposits of quicksilver, mixed with rock, filling natural vertical holes in gypsum. (Halse)

Trolley; Trolly. 1. A small four- or two-wheeled truck, without a body. The two-wheeled trolley is used in a rolling-mill to wheel the puddle-balls to the squeezer. (Raymond)
2. The grooved wheel, fixed in bearings at the end of a flexible pole, pressed upward in rolling contact with the overhead wire to take off the electric current (Webster). The term is frequently applied to the flexible pole, which is properly *trolley pole.*
3. (Brit.) A basin-shaped depression in strata (Gresley). Also called Lum.

Trombe; Trompe (Fr.). An apparatus for producing an air-blast by means of a falling stream of water, which mechanically carries air down with it, to be subsequently separated and compressed in a reservoir or drum below. (Raymond)

Tromel (Sp.). A revolving screen; a trommel; *T. classificador*, a grading trommel; *T. de desenlodar*, a cleaning or washing trommel. (Lucas)

Trommel. 1. A revolving sieve for sizing ore (Raymond). Also called according to its various uses, Sizing trommel, Washing drum, Washing trommel. (Standard)
2. To separate coal into various sizes by passing it through a revolving screen. (Gresley)

Trompa Mex.). 1. The nose of chilled slag over a tuyère. (Dwight)
2. A water blast. (Halse)

Trompe (Fr.). *See* Trombe.

Trompille (Fr.). The air tube of a trompe (trombe) for a blast furnace. Also spelled Trompil. (Standard)

Trompo (Mex.). Foot of a stull or post. (Dwight)

Trona. An impure form of hydrous sodium carbonate. (U. S. Geol. Surv.)

Tronco (Mex.). Team of horses or mules. (Dwight)

Tronera (Mex.). Chimney; channel; flue. (Dwight)

Tront (Mid.). A long sprag fixed diagonally to the face of the coal wall. (Gresley)

Troostite. 1. A variety of Willemite, in large reddish crystals, Zn_2SiO_4, in which the zinc is partly replaced by manganese. (Dana)
2. A transition substance in steel whose limits are defined by the presence of martensite and osmondite respectively. (Webster)

Trouble. A dislocation or fault; any irregularity in a coal bed (Chance). Also called a Throw, Slide, Slip, Heave, or Check.

Trough. 1. A hollow or undulation in a mineral field, or in a mineral working (Barrowman). In geology, synonymous with Basin and Synclinal.
2. A conduit for conveying water.
3. A buddle or other vessel in which slimes are sorted in water. 4. A fire-clay box in which iron bars are subjected to the cementation process. (Webster)

Trough fault. In geology, two faults having nearly the same direction, but dipping toward each other, so that the mass of rock included between them has more or less the form of a wedge. (Century)

Trough joint (Eng.). The fissure or joint that frequently accompanies the abrupt bending of strata passing through the middle of the curvature. (Page)

Trough washer. In its simplest form it is a sloping wooden trough, 1½ to 2 feet wide, 8 to 12 feet long and 1 foot deep, open at the tail end, but closed at the head end. It is used to float adhering clay or fine stuff from the coarser portions of an ore or coal (Liddell). A log washer.

Troughman. One who takes care of the runner at pig-casting machine, while iron is being poured from ladle cars; bars out scrap and prepares the runner for the next cast. (Willcox)

Trow. A wooden channel for air or water. (Raymond)

Trowhole; Trowroad (Scot.). A steep road, down which mineral slides instead of being loaded in hutches, or cars. (Barrowman)

Trowlesworthite. A variety of granite that has been so altered by fumarole action that it consists of fluorite, orthoclase, tourmaline and some quartz, the last named having been largely replaced by the first. The name is derived from an English locality, and was given by Worth. (Kemp)

Troy. A system of weight measures formerly used for various articles, but now only by goldsmiths and jewelers (Standard). *Troy weight.* The weight system used in making assay returns for gold, silver or other precious metals.

Troy ounce. The one-twelfth part of a pound of 5760 grains; that is, 480 grains. It equals 20 pennyweights, 1.09714 avoirdupois ounces, 31.1035 grams, and has a fine gold value of $20.67 or 85 shillings. This is the ounce designated in all assay returns for gold, silver, or other precious metals.

Troy pound. A unit of weight equal to 5,760 grains, 240 pennyweights, 13.1657 avoirdupois ounces, 0.82286 avoirdupois pound, 373.2509 grams, and has a fine gold value of $248.04 or £51.

Truck. 1. A small tram-car for carrying coal, rock, or ore along a level in a mine, or out to a chute or a dump. 2. Goods paid instead of money for wages. (Roy. Com.) 3. Any of numerous vehicles for transporting heavy articles; any of various small flat-topped cars for pulling or pushing by hand used in shops or railroad stations; any strong heavy cart or wagon either horse-drawn or self-propelled. 4. An open railroad freight car. (Webster)

Truck system. Paying miners in food or merchandise instead of money (Steel). *See* Truck, 2.

True fissure vein. A fissure vein with promise of extending to great depth, in contradistinction to a *gash* vein. All mineralized fissures are true fissure veins. (Weed)

True lode. A fissure vein. (Skinner)

Trueque (Mex.). A truck or trolley (for tramway bucket). Truck of railway car. (Dwight)

True vein. An occurrence of ore, usually disseminated through a gangue of veinstone, and having more or less regular development in length width, and depth (Century). *See* Vein, *also* Fissure vein.

Truite. In ceramics, having a delicately cracked surface; said of Japan ware and porcelain. (Standard)

Truller (Corn.). A miner who wheels ore in barrows. (Standard)

Trumpeting (Eng.). A channel or passage partitioned off from a shaft or left behind the lining, usually running along one corner of the latter (Webster). Used for ventilation.

Trumpet lamp (No. of Eng.). A miner's term for a Mueseler or Belgian safety-lamp. (Gresley, 1883)

Truncheon (Som.). A sleeper (tie) for undergrcund railways (Gresley). A small railway tie.

Trunk. 1. (Mid.) A wooden box or sled in which the débris is conveyed from a small heading. 2. (Brist.) A wooden pipe or box for conveying air in the workings. 3. (York.) *See* Kibble. (Gresley) 4. A long narrow, inclined box, in which the separation of the fine ore from the earthy impurities is effected. (Whitney) 5. A launder for conveying slimes, etc. 6. To separate slimes by means of a trunk, 4, for further treatment. (Webster)

Trunking (Corn.). Separating slimes by means of a trunk, 4. (Raymond)

Trunk pumping-engine. A pump that commands the drainage of underground waters over a considerable area of mine workings, being a substitute for a number of smaller and independent pumps. (Gresley)

Trunnion. A cylindrical projection, journal, or gudgeon attached to each of two sides of a vessel, so that it can rotate in a vertical plane, as in a molding flask, a converter, etc. (Webster)

Trunnion plate. A metal-plate lining the bearing or recesses in which the trunnions rest. (Webster)

Trunt (No. Staff.). A heading driven on a level. (Gresley)

Truss. An assemblage of members, such as beams, bars, rods, and the like, so combined as to form a rigid framework; that is, one which can not be deformed by the application of exterior force without deformation of one or more of its members. (Webster)

Trying the lamp (Eng.). The examination of the flame of a safety lamp for the purpose of judging the quantity of fire damp mixed with the air. (Gresley)

Tsehong (China). A red pigment consisting of white lead mixed with aluminic, ferric, and silicic oxides; used by the Chinese in decorating porcelain. (Standard)

Tsing-lien (China). A red pigment consisting of stannic and plumbic silicates mixed with small quantities of copper oxide o: cobalt and gold; used by the Chinese in decorating porcelain. (Standard)

Tub. 1. An iron or wooden barrel, box, or bucket used in a shaft, for hoisting material. 2. A Keeve. 3. A tram used underground. 4. To line with tubbing; to keep back water by tubbing. *See* Tubbing. (Webster)
5. (Eng.). A complete length of metal or timber tubbing from and inculding the wedging crib upward. (Gresley)

Tubbed back (or off) (Eng.). Springs or feeders of water found in shafts are said to be "tubbed back" (or tubbed off) when tubbing has been put in to keep the water out of the mine. (Gresley)

Tubber. In mining, a double-pointed pickax; a beele. (Standard)

Tubber man. In mining, a man who uses a tubber. (Standard)

Tubbing (Eng.). A lining of timber or metal for a shaft, especially a water-tight shaft lining consisting of a series of cast-iron cylinders bolted together, used in sinking through water-bearing strata (Webster). A shaft lining of casks or cylindrical caissons, of iron or wood. *See* Plank-tubbing. (Raymond)

Tubbing deals (Scot.). Plank put behind tubbing in a shaft. (Barrowman)

Tubbing plate (Eng.). A cast-iron segment of a ring of tubbing. (Gresley)

Tubbing wedge. A small wooden wedge driven between the joints of tubbing plates. (C. and M. M. P.)

Tube blower. A man who cleans boiler tubes. (Willcox)

Tube clamp. A clamp or clip for gripping a tube or pipe; especially, a jawed tool used in hoisting and lowering well tubes. (Standard)

Tube mill. A revolving cylinder, usually lined with silex, nearly half filled with glacial or water-worn flints, used for fine grinding of certain ores, preliminary to further treatment. The material to be ground, mixed with water, is fed through a trunnion at one end, and passes out of the opposite trunnion, as a slime.

Tube packing. A bag of flaxseed, or ring of rubber, made to occupy the space between the tube of an oil well and the bored hole to prevent access of water to the oil-bearing stratum. (Nat. Tube Co.)

Tubería (Sp.). Tubing; a set of pipes or tubes; *T. aspirante*, suction tubing; *T. de descarga*, the delivery pipe of a pump. (Halse)

Tubing. 1. The tube-lining of bore holes; casing. 2. The act of lining a deep bore hole by driving down iron tubes (Ihlseng). *See* Casing, 3.
3. Hollow cast-iron segments placed in a shaft to dam back water or sink through quicksand. Also spelled Tubbing. (Steel)

Tubo (Sp.). 1. Tube, pipe. 2. *T. de humo*, a smokestake. 3. A tunnel. (Halse)

Tub rider (India). A trip rider.

Tubule. In geology, an irregular, hollow, twig-like calcareous concretion characteristic of the loess. (Standard)

Tub way (No. of Eng.). A tramway for handling tubs of ore, coal, etc.

Tucker (Aust.). 1. Work by which a miner is hardly able to make a living. (Century)
2. "Grub", food, or rations.

Tucker ground (Aust.). Ground containing poor or lean ore. (Davies)

Tuck-joint pointing. Pointing in which the mortar projects as a fine ridge between the stones or bricks. (Standard)

Tucurababi (Sonora, Mex.). An altered granite. (Halse)

Tucurubay (Mex.). A kind of gravel. (Lucas)

Tue-iron. 1. Same as tuyère. 2. In the plural, blacksmiths' tongs. (Standard)

Tufa. A chemical sedimentary rock composed of calcium carbonate or of silica, deposited from solution in the water of a spring or of a lake or from percolating ground water; sinter. Should not be confused with Tuff, *which see.* (La Forge Called also Calcareous tufa; Calc-tufa. *See* Travertine.

Tufaceous. Of, pertaining to, or like tufa (Webster). *Compare* Tuffaceous.

Tuff. A sedimentary rock composed of fine material—volcanic dust, so-called ash and cinders, and lapilli—explosively ejected from a volcano. Tuff may or may not be deposited in water; it may be either heterogeneous or rather well sorted, and it may be either incoherent or indurated. (La Forge) *Compare* Tufa.

Tuffaceous. Characteristic of, pertaining to, containing, or resembling tuff. Not to be confused with Tufaceous. (La Forge)

Tuff breccia. A stratified tuffaceous rock in which the fragments are angular and larger than in a tuff. (Ransome)

Tuff cone. A volcanic cone made up chiefly or wholly of tuff and other fragmentary explosively ejected material. (La Forge)

Tuft (Eng.). A soft sandstone; also calcareous deposits (Bainbridge). Probably a variation of Tufa.

Tug. (Eng.) An iron hook of a hoisting tub, to which a tackle is attached. (Webster)

Tugger (Brist.). A short chain by which boys draw tubs along. (Gresley)

Tugger boy (Brist.). One who draws small tubs or sleds underground by means of a tugger. Called Tugger-work. (Gresley)

Tugwith (Derb.). A small pole or sapling used as a brake on a windlass or turntree. (Hooson)

Tula metal. An alloy of silver, copper, and lead, made in Tula, Russia, used in making niello, 3. (Webster)

Tully limestone. A limestone lying between the Genesee shale and the Hamilton shale, and forming the base of the Upper Devonian in central New York. (Century)

Tumbar. 1. (Mex.). To break down ore, etc. (Dwight)
2. (Colom.) To direct mine workings in such a way, that from want of proper security, they are destroyed. (Halse)

Tumbe (Mex.). The act of breaking and removing ore. (Dwight)

Tumble. To smooth, clean, or polish, as castings, by friction with each other or with a polishing material, in a rotating box or barrel; to rattle. (Standard)

Tumbler. 1. A projecting piece on a revolving shaft or rockshaft, for actuating another piece. In dredges, there is an upper and a lower tumbler supporting the bucket line. (Weatherbe)
2. (Scot.). A tipping apparatus for tubs or wagons. (Barrowman)
3. (No. of Eng.) A stop, scotch, or catch, affixed to each deck of a cage for keeping the tubs in place. (Gresley)
4. (Derb.) Any stone that is too large to go into the hoisting bucket. (Hooson)

Tumble-up (So. Wales). Space by the side of the haulage way for the empty tram or car to be turned over so that the full car or tram can pass it.

Tumbling barrel. A revolving cask or barrel in which nails are polished, as by mutual attrition, or in which small castings are put to break out thin cores. Called also, Rattle barrel, Rattler, Rumbler, and Tumbling box. (Webster)

Tumbling crank (Scot.). A crank on the end of the pump shaft for giving reciprocating motion. (Barrowman)

Tumbling shaft. The cam shaft used in stamp mills. (Century)

Tumbling tom (Eng.). A car-tipping or dumping apparatus that turns completely over. (Gresley)

Tumbling trough. A receptacle made of pottery, operated on the principle of a tumbler tank, for dumping nitric acid at intervals in the manufacture of sulphuric acid. (Standard)

Tummals; Tummels (Corn.). A great quantity, or heap, as of ore.

Tumpago (Sp. Am.). Low-grade gold. (Lucas)

Tumphy (Scot.). A carbonaceous fire clay. A clay containing streaks of coal. (Barrowman)

Tumulose. Full of small hills and mounds. (Webster)

Tumulus. A swelling, or low dome-like hill, formed in congealed lava flows (Daly, p. 133)

Tundra (Russ.). One of the level or undulating treeless plains characteristic of Arctic regions in both hemispheres. The tundras mark the limit of arborescent vegetation; they consist of black mucky soil, with a permanently frozen subsoil, but support a dense growth of mosses and lichens, as the reindeer moss, and dwarf cespitose herbs and shrubs often showy-flowered. (Webster)

Tundra placers (Alaska). *See* Gravel-plain placers.

Tune work. Labor paid for by the day or the hour, in opposition to piecework. (Century)

Tungsten. A rare element of the chromium group found combined in certain minerals, as wolframite and scheelite, and isolated as a hard, brittle, white or gray metal. Symbol, W; atomic weight, 184.0; specific gravity, 16.6 to 19.0. (Webster)

Tungsten steel. An alloy steel containing from 6 to 10 per cent of tungsten. An extremely hard alloy which does not lose its hardness by friction with iron, and is hence used for iron-cutting tools and for magnets. (Standard)

Tungstic ocher. Same as Tungstite, WO_3. (Standard)

Tungstite. A yellow or yellowish-green pulverulent mineral, tungsten trioxide, WO_3. (Dana)

Tunna (Wales) A hoisting bucket; a bowk; a kibble. (Gresley)

Tunnel. 1. A tunnel, strictly speaking, is a subterranean passage open at both ends. An *adit*, if continued through a hill, would then be a tunnel (Skinner). Any level or drift in a mine open at one end, or which may serve for an adit. *See* Adit (Century). Often used as a synonym for Adit, Drift, Gallery.
2. (Penn.) A crosscut through or across barren measures is often called a tunnel, or a rock tunnel; an anthracite term.
3. In marble quarrying, the term is applied to a subterranean working level, or incline, having a roof of undisturbed rock. (Bowles)
4. To make an opening, or a passageway through or under, as to tunnel a mountain; to cut, blast, or otherwise make a tunnel. 5. A chimney opening for the passage of smoke; a flue; funnel. 6. In sulphuric acid manufacture, a tube of sheet lead, connecting adjoining leaden chambers when used in series. (Webster)

Tunnel blasting. A method of heavy blasting in which a heading is driven into the rock and afterwards filled with explosives in large quantities, similar to a bore hole, on a large scale, except that the heading is usually divided in two parts on the same level at right angles to the first heading, forming in plan a "T", the ends of which are filled with explosives and the intermediate parts filled with inert material like an ordinary bore hole (Du Pont). Similar to Gopherhole blasting.

Tunnel borer. Any boring machine for making a tunnel; often a ram armed with cutting faces operated by compressed air. (Standard)

Tunnel column. A heavy bar used for mounting machine drills in large drifts or tunnels, and usually holding two machines. (Gillette, p. 96)

Tunnel disease. 1. Caisson disease. 2. Ankylostomiasis. (Webster)

Tunnel head. The top of a shaft furnace. (Raymond)

Tunnel hole. The throat of a blast furnace. (Century)

Tunnel kiln. A lime kiln having a tunnel for the consumption of coal, as distinguished from a flame-kiln, where wood is burned. (Standard)

Tunnel right. The right of the possession of all veins or lodes encountered, and not previously known to exist, within 3,000 ft. from the surface (portal) of a tunnel driven for development, and 300 feet on each side of the center line of the tunnel, if the vein is parallel with the tunnel. If the vein crosses the tunnel at right angles a claim may be located 1,500 feet on either side of the tunnel, or partly on one side and partly on the other, but not exceeding 1,500 feet in length. (U. S. Min. Stat., pp. 165, 175)

Tunnel set. Timbers 6 to 8 inches in diameter and of sufficient height to support the roof of the tunnel. They are sometimes set upon sills and usually capped with short cross pieces. (Chandler *v.* Utah Copper Co., 135 Pac. Rept., p. 106)

Tunnel shaft. A shaft sunk, as in a hill, to meet a horizontal tunnel. Called also Tunnel pit. (Standard)

Tunnel system. A method of mining, in which tunnels or drifts are extended at regular intervals from the floor of the pit into the ore body. The extension of the drift beyond the working face is made great enough to facilitate the handling of several cars at a time. The ore is mined above the drift level, and the cars are loaded by lifting short boards which span an opening, through the lagging on, and above, the center line of the drift. The method avoids the construction of raises and chutes, and facilitates the filling of the cars. (Young)

Tup. 1. (Eng.) An early custom of covering with lighted candles the last corf of coal sent to the bank at the beginning of the fortnight's holiday at the end of the year when stock was taken and no coal hoisted. This was called "sending away the tup." (G. C. Greenwell)
2. The ram or monkey, or falling weight of a pile driver, drop hammer. etc. (Webster)

Tupia (Sp.). A dike or dam. (Lucas)

Tupiar (Sp.) To make dikes or dams.

Turba (Sp.). 1. Turf, peat. 2. Dung mixed with coal and molded into *adobes* and used as fuel in brick kilns. (Halse)

Turbary (Eng.). An easement to dig turf or peat on another's land; also the ground where the turf is dug. (Webster). A right of *turbary* is confined to such quantity of land as is sufficient for the house into which the common is appendant. (Bainbridge)

Turbera (Sp.). Peat deposit. (Lucas)

Turbina (Sp.). A turbine. (Dwight)

Turbine. 1. A rotary motor actuated by the reaction, impulse, or both, of a current of water under pressure. There are several types. 2. A form of steam engine analogous, in construction and action, to the water turbine. There are two distinct kinds, typified in the de Laval and the Parsons and Curtis turbines. (Webster)

Turbine pump. A turbine wheel arranged to raise water by rotation in the opposite direction to that in which it would turn if used as a motor. (Standard)

Turf. Peat. There are several varieties, as white, brown, black, stone, gas, or candle turf. (Power)

Turfary (Eng.). A place where turf or peat may be got. (Webster)

Turf charcoal. Same as peat charcoal. (Standard)

Turfing iron; Turfing spade. An implement for cutting and paring off turf. (Webster)

Turf spade. A long narrow spade for cutting and digging turf, peat, etc. (Standard)

Turgite; Hydrohematite. An iron ore intermediate between hematite and limonite, consisting of hydrous ferric oxide, $2Fe_2O_3.H_2O$. (Dana)

Turkey-fat (Mo.). A local name for a variety of smithsonite, colored yellow by greenockite; so called from its appearance. (Chester)

Turkey slate. A whetstone or honestone. *See* Turkey stone. (Power)

Turkey stone. 1. A very fine, close-grained stone containing about 75 per cent silica, and 25 per cent calcite. Quarried in the interior of Asia Minor. Once very popular for sharpening mechanics' tools but now superseded largely by Arkansas and Washita oilstone (Pike). Novaculite; also called Turkey slate.
2. Turquoise. (Standard)

Turkis (Archaic). A turquoise. (Standard)

Turkois. Same as Turquoise. (Standard)

Turmeric paper. A test paper colored yellow by turmeric, and used for testing alkaline substances when the color changes from yellow to brown, and for boric acid which turns it to a reddish brown. (Webster)

Tur-min-tine. A petroleum substitute for turpentine. (Bacon)

Turn. 1. The time or period during which coal, etc., is raised from the mine. Called Run in Arkansas. A shift. 2. To open rooms, headings, or chutes off from an entry or gangway. 3. The number of cars allowed each miner. *Good turn*, many cars for each miner. (Steel)
4. (Eng.) A pit sunk in some part of a drift. (Webster)
5. To draw or wind coal up a shaft or up an inclined plane to the surface. 6. Curved tram rails laid round a corner or turn, often made of cast iron. (Gresley)
7. To set (undried bricks) on edge to facilitate drying. (Standard)

Turn again (No. Staff.). A change in the direction of the dip of the strata. (Gresley)

Turn barrel (Mid.). A hand windlass; also called Jack roll. (Gresley)

Turn bat. A wooden stick used in turning the tongs which hold a bloom under the hammer. (Raymond)

Turn beam (Eng.). Either of the beams on which a kind of self-acting hoisting machine turns. (Webster)

Turnerite. A yellowish-brown variety of monazite. (Standard)

Turnhouse (Corn.). The point where the miner turns from a crosscut along the course of a lode (Davies). The first cutting on the lode after it is cut in a crosscut. (Min. Jour.)

Turning. 1. (Eng.) Drilling a shot hole by hand. (Gresley)
2. In ceramics, the process of removing the surface of green pottery to make its shape true before firing. (Standard)

Turning out (So. Staff.). Bringing coal to the skips. *See* Turnout, 2. (Gresley)

Turno (Mex.). A shift of work. (Dwight)

Turn-off. 1. (Aust.) The point where a branch tram line leaves the main line.
2. (Aust.) A siding or passing place for skips on a haulage road (Power). A turnout.

Turnout. 1. A siding or by-pass upon an underground haulage-way. (Gresley)
2. (Ark.) To shovel coal toward the track for more convenient loading. (Steel)

Turn pulley. A sheave fixed at the inside end of an endless- or tail-rope hauling plane, around which the rope returns. A tail sheave. (C. and M. M. P.)

Turn stakes (Eng.). A windlass. (Gresley)

Turntable. A revolving platform on which cars or locomotives are turned around. (C. and M. M. P.)

Turntree (Derb.). A sort of windlass for hoisting ore. (Hooson)

Turpentine substitutes. Petroleum products usually intermediate between gasoline and illuminating oil (49° naphtha). They vary in gravity from 40° to 58° Bé., and are said to be more homogeneous than burning oils. As they are designed for paint thinners and for admixture with turpentine, they should evaporate without leaving residues or stains. (Bacon)

Turquesa (Sp.). Turquoise. (Dwight)

Turquoise. Hydrous phosphate of aluminum colored by a copper compound. $AlPO_4.Al(OH)_3+H_2O$. Used for the well-known gem of the same name. (Dana)

Turrelite. A Texas asphaltic shale. (Bacon)

Turtle stones. Large nodular concretions found in certain clays and marls. In form they have a rough resemblance to turtles, and this appearance is increased by their being divided into angular compartments by cracks filled with spar, reminding one of the plates on the shell of a turtle. They are common in the cretaceous marls of the Northwest territories, Canada. (Roy. Com.) *See* Septarium.

Tushkar. *See* Tuskar.

Tuskar (Iceland). A turf cutter; a peat spade (Webster). Called also Tushkar; Twiscar.

Tusru (Japan). A pick used for loosening auriferous gravel preliminary to washing. (Lock)

Tut (Corn.). To perform a piece of work at a fixed price. (Pryce)

Tutunia. A white alloy consisting chiefly of tin with varying proportions of antimony, copper, bismuth, and sometimes brass or steel; for making tableware, etc. (Standard). A trade-name for Britannia metal.

Tutenag. 1. A white alloy, resembling German silver, used in making tableware, etc., with varying proportions of copper, zinc, and nickel, and sometimes a little lead or iron. 2. Zinc or spelter, especially that from China and the East Indies. (Standard)

Tut money (Eng.). Pay for tutwork, overtime, etc. (Webster)

Tutty. An impure zinc oxide obtained as a sublimate in the flues of zinc-smelting furnaces, and used as polishing powder. (Standard)

Tutwork (Corn.). Excavation paid for by measure or by weight, an extra credit being usually allowed for timber work, and a debit charged for certain sundries, as candles, explosives, tools, etc., supplied by the mine owner. (Webster)

Tuyère; Tweer; Twyer; Twere. A pipe inserted in the wall of a furnace, through which the blast is forced into the furnace. Usually the tuyère enters through an embrasure in the masonry (tuyère-arch). A nozzle or interior pipe is frequently inserted at the inner end of the tuyère. By changing the nozzle, the size of the opening for the blast may be thus regulated without changing the tuyère. The latter is either an annular hollow casting of iron (box-tuyère) or bronze (bronze tuyère), or a coil of iron pipe. In either case, water is continually circulated through it, to protect it and the nozzle from the action of the melting materials in the furnace. Spray-tuyères are open box-tuyères, in which a spray of water, instead of a current, is employed. This is vaporized by the heat, and passes away as steam. (Raymond)

Tuyère arch. An arch in a blast furnace to admit a tuyère (Standard). *See* Tuyère.

Tuyère man. One who fits and tests tuyères, plates and coolers that they may be ready for replacement in a furnace on short notice. (Willcox)

Tuyère pipe. A tuyère, or a pipe leading to a tuyère. (Standard)

Tuyère plate. A plate in the side of a forge through which the tuyère passes. *See* Bloomery.

Twaddell. A form of hydrometer for liquids heavier than water, graduated with an arbitrary scale such that when the readings are multiplied by 0.005, and added to unity give the specific gravity. (Webster)

Tweer; Twere. *See* Tuyère.

Twibill (Eng.). A strong pick generally with a rectangular eye, used for stonework (Gresley). A tool like a pickax, but having instead of the points, flat terminations, one parallel to the handle, and the other perpendicular to it. (Webster)

Twig. 1. A divining rod. 2. A thin strip of plastic fire clay used in ceramic modeling, especially in imitation basket work. (Standard)

Twin boy (Brist.). A small boy employed underground to push trams along a twinway. (Gresley)

Twin crystals. Crystals in which one or more parts, regularly arranged, are in reverse position with reference to the other part or parts. They often appear externally to consist of two or more crystals symmetrically united, and sometimes have the form of a cross or star. They also exhibit the composition in the reversed arrangement of part of the faces, in the striæ of the surface, and in reentering angles; in certain cases the compound structure can only be surely detected by an examination in polarized light (Dana).

Twin entry. A pair of parallel entries, one of which is an intake and the other the return air-course. Rooms can be worked from both entries. Often called double entry.

Twinning axis. The axis about which one part of a twin crystal may be conceived to have been rotated 180° with relation to the other part. (La Forge)

Twinning law. The special and characteristic method according to which twin crystals of any mineral are formed. (La Forge)

Twinning plane. In a twin crystal, a plane normal to the twinning axis. (La Forge)

Twin seam (Aust.). Two seams of coal so close together that they can be worked in conjunction, or one following closely on the other. (Power)

Twin way (Brist.). Two branch roads one on either side of a main road driven to the working face, through which trams are pushed by twin boys. (Gresley)

Twiscar. *See* Tuskar.

Twitch; Twith (No. of Eng.). A pinch in a vein. (Power)

Two (Scot.). A cageful of men (Gresley). A term no doubt originating when cages were small and could accommodate only two men.

Two throws (Eng.). A depth of about 12 feet when the débris from sinking shaft has to be raised to surface by two lifts or throws with the shovel (one man working above another). At this point the employment of a hand windlass becomes necessary. (Gresley)

Twyer. *See* Tuyère.

Tye. 1. (Eng.) The point where two veins cross each other or where two pipes cross obliquely. (Hunt)
2. (Corn.) An adit or drain. (Davies)
3. (Corn.) A sluice box for the extraction of the heavy sands in mill tailings. Sometimes spelled Tie. (Raymond)

Tyer; Tier of pumps (Corn.). A set of pumps of which the lower pump or piece is called the Driggoe, but more frequently the working piece. (Pryce)

Tying (Corn.). The washing of ore in a strake, tye, or launder.

Tymp. 1. A hollow iron casting, cooled interiorly by a current of water and placed to protect the tymp-arch, or arch over the dam, in a blast furnace having a fore-hearth. *See* Open front. (Raymond)
2. (Eng.) A horizontal roof-timber in a coal mine; a cap or lid. (Standard)

Tymp-arch. The arch covering the fore hearth of a blast furnace. (Standard)

Tymp-plate; Tymp stone. A plate or stone forming a tymp. (Standard). *See* Tymp-stone.

Tymp-stone. A large clay plug filling an open space in the front jackets of a smelting furnace, through which the tap-hole passes. (Standard)

Type locality. The place at which a formation is typically displayed and from which it is named; also the place at which a fossil or other geologic feature is displayed in typical form. (Ransome)

Type metal. An alloy used for making type. It consists essentially of lead, (four parts) and antimony (one part), often with a little tin, nickel or copper. It expands slightly on cooling. (Webster)

Types (Scot.). Irregularities in a mine roof; also called Lypes. (Gresley)

Type specimen. The specimen or individual on which the original scientific description of a given species or subspecies is based. (Webster)

Typhonic rocks. Brogniart's name for rocks that have come from the depths of the earth, *i. e.*, plutonic and eruptive rocks. Typhon is used as a synonym of boss or stock. (Kemp)

Tyrite. A variety of fergusonite found near Arendal, Norway. (Century)

Tyrolite. A hydrous arsenate of copper, occurring in orthorhombic crystals, and in aggregates having a foliated micaceous structure. (Century)

Tyth (Eng.). An ancient custom or duty which miners gave to the priests. Usually every twentieth dish. (Hunt)

U.

Ucha (Sp. Am.). Llama-dung. *See* Taquia. (Halse)

Uda. 1. In ceramics, a purplish-brown pigment used in the decoration of Hindu pottery. 2. Glazed pottery thus decorated. (Standard)

Uged (Derb.). Loose, weak, liable to fall, sounding hollow, or unsound. (Gresley)

Uintahite. *See* Gilsonite.

Ulexite; Cotton ball. Hydrous borate of sodium and calcium, probably $NaCaB_5O_9.8H_2O$. Contains theoretically 48 per cent B_2O_3. Analyses of the natural mineral show 42 to 45.3 per cent B_2O_3. (U. S. Geol. Surv.). Called also Boronatrocalcite.

Ullmannite. Sulphantimonide of nickel, NiSbS or $NiS_2.NiSb_2$; arsenic is usually present in small amount. (Dana)

Ultimate analysis. The determination of the elements contained in a compound as distinguished from *proximate analysis*, which is the determination of the compounds contained in a mixture. (Standard)

Ultimate tensile strength. Same as tensile strength. (C. M. P.)

Ultrabasic. Containing less than 35 per cent silica; containing virtually no quartz or feldspar and composed essentially of ferromagnesian silicates, metallic oxides and sulphides, and native metals, or of all three: said of some igneous rocks and of most varieties of meteorites (La Forge)

Ultramarine. 1. A pure blue pigment, prepared by powdering lapis lazuli. 2. An artificial pigment resembling the above in composition, but having commonly a tinge of violet. Also called French blue, Gmelius blue. 3. Any of several pigments, most of which are produced by modifications of the above processes, as green ultramarine, purple ultramarine. (Webster)

Ultramarine ash. A pigment used for gray tints and made by grinding the residue from lapis lazuli after the natural ultramarine has been removed. (Standard)

Ultramarine yellow. A lemon-yellow pigment consisting of barium chromate. (Webster)

Ultra-violet. Outside of the visible spectrum at its violet end; said of rays more refrangible than the extreme violet rays (Webster). Willemite when exposed to these rays displays a bright green color. Doubtful zinc ore is often roughly tested in this manner.

Umangite. A selenide of copper, CuSe Cu_2Se, in dark red masses. (Webster)

Umber. A chestnut-brown to liver-brown hydrated ferric oxide, containing manganese oxide and clay: used as a pigment; also, the color. As found in nature the oxide is called Raw umber, and when heated, so as to produce a reddish brown, it is called Burnt umber. *Cologne* or *German umber* is a brownish pigment from lignite. (Standard)

Umbral. In geology, the eleventh series of the Pennsylvania system of rocks, comprising substantially the Mauch Chunk red shale of the Upper Subcarboniferous (Standard). Now obsolete.

Umbrella. A bonnet, or hood over a hoisting cage. (Gresley)

Umiak (Alaska)). A large, Eskimo boat made of skins; it is larger than kayak.

Umpé (Sp., Am.). Fire damp; foul air. (Lucas)

Umpire. 1. A person to whose sole decision a controversy or question between parties is referred (Webster), as one who performs control assays. 2. An assay made by a third party to settle a difference found in the results of assays made by the purchaser and seller of ore.

Umptekite. A sodium-rich variety of syenite composed essentially of microperthite and sodic amphibole, with a little nephelite and in some phases a little aegirite. (La Forge) The accessory minerals are numerous. (Kemp)

Unconformability. *See* Unconformity.

Unconformability by erosion. The presence of an irregular sinuous surface of contact between two contiguous strata, indicative of intervening elevation and erosion, not necessarily accompanied by flexure. (Standard)

Unconformability of dip. Discrepancy between the dip of an overlying and an underlying stratum, indicating a movement of the lower stratum before the deposition of the upper one; ordinary unconformability, referred to when no qualifying epithet is used. (Standard)

Unconformability of overlap. Discrepancy in areal extent between two contiguous superimposed strata, even where they have the same dip, the edge of one stratum overlapping that of the other; indicative of gentle subsidence without perceptible folding. Called also by European geologists *unconformability* of *transgression*. (Standard)

Unconformable. Having the relation of unconformity to the underlying rocks; not succeeding the underlying strata in immediate order of age and in parallel position. (La Forge)

Unconformity; Unconformable. 1. Discordance in attitude with the underlying rocks, due to overlap or to a lapse in deposition, during which the rocks beneath were deformed or partly eroded away or both. 2. The surface of contact between unconformable strata and the rocks beneath them. (La Forge)

Unctuous. Having a greasy, oily, or soapy feel when rubbed or touched by the fingers, as talc, serpentine, etc.

Undercast. An air course carried under another air course or roadway (Steel). *Compare* Overcast.

Under clay. A stratum of clay beneath a coal bed often containing roots of coal plants, especially *Stigmaria*. (Webster)

Undercliff. 1. (So. Wales) An argillaceous shale forming the floor of many coal seams. (Gresley) 2. (Eng.). That portion of a cliff which has fallen *en masse* along a considerable line of coast, and forms a subordinate terrace between the sea and the original shore (Page). *Compare* Talus.

Undercurrent. A large, flat, broad, branch sluice, placed beside and a little lower than the main sluice. This apparatus is paved and riffled like the sluice, but being much wider than the latter, allows the water to spread out in a thin sheet over its surface, thereby so abating the velocity of the current that the very fine gold, including the rusty particles, is more apt to be caught here than in the sluice. (Hanks)

Undercut. 1. To undermine, to hole, or to mine. To cut below or in the lower part of a coal bed by chipping away the coal with a pick or mining machine. It is usually done on the level of the floor of the mine, extending laterally the entire face and 5 or 6 feet into the material. 2. In founding, the part of a molder's pattern that would break the sand if drawn vertically from an ordinary mold. (Standard)

Undercut quarry. A quarry in which the walls slant outward (overhang working face) so as to make the floor space wider with increasing depth. (Bowles)

Undercutting. A term applied to the process of cutting under the face of the coal with a machine so it can be shot down readily. (Consolidated Coal Co. *v.* Gruber, 188 Illinois, p. 589). *See* Undercut.

Under-dip coal (Scot.). Coal extending below the haulage level at the bottom of the shaft. (Barrowman)

Underearth (Forest of Dean). A hard fire clay forming the floor of a seam of coal. (Gresley)

Underedge stone (Forest of Dean). The floor of an iron-stone mine. (Gresley)

Underfire. 1. In ceramics, to fire insufficiently; to shortfire. 2. To fire from beneath. (Webster)

Underflow. In geology, the water flowing beneath the beds of rivers, and also under the bottom lands of the river valleys, especially in arid regions. (Standard)

Under-getting (Eng.). *See* Shorts, 3.

Underglaze. In ceramics, a color applied before the glaze is put on. (Webster)

Underground milling. *See* Underhand stoping.

Underground shaft. A shaft sunk from an adit, tunnel or working level, through which mining operations are conducted. The upper end terminates underground. A winze or raise becomes an underground shaft when equipped and used for hoisting and the conduct of other mining operations.

Underground station. 1. An enlargement of an entry, drift, or level at a shaft at which cages stop to receive and discharge cars, men, and material. 2. An underground place in which there are installed transformers, switchboards, or electrical machines other than portable motors, or any one of them. (H. H. Clark). 3. A pump station.

Underground-water. *See* Ground water.

Underhand quarrying of panel cores (Mitchell system). *See* Underhand stoping.

Underhand stoping. Mining downward. The stope may start below the floor of a level and be extended by successive horizontal slices, either worked sequentially or simultaneously in a series of steps. The modifications consist in the working of the block by a series of slices parallel with the dip, each slice being worked from the top down and the slices being taken in sequence. The stope may be left as an open stope or supported by stulls or pillars. Filling can be used after the stope has been finished or may follow the stope as a back fill (Young). Sometimes called Horizontal cut underhand, Underhand quarrying of panel cores (Mitchell system), Underground milling, and Open stope method.

Underhand work. Picking or drilling downward. (Ihlseng)

Underhole; Undermine. To mine out a portion of the bottom of a seam, by pick or powder, thus leaving the *top* unsupported and ready to be blown down by shots, broken down by wedges, or mined with a pick or bar (Chance). *See* Undercut. In England the terms Jad, Hole, Undercut, Kirve, and Bench are synonymous.

Underlay; Underlie. 1. (Corn.) The departure of a vein or stratum from the vertical, usually measured in horizontal feet per fathom of inclined depth. Thus a dip of 60° is an underlay of three feet per fathom. The underlay expressed in feet per fathom is six times the natural cosine of the angle of the dip (Raymond). The complement of Dip; Hade. 2. The downward extension of a vein or bed beneath the ground. Mineral bodies lying under a given tract, though not outcropping on surface. (Weed)

Underlay shaft; Underlier. A shaft sunk in the footwall and following the dip of a vein.

Under-level work (Clev.). Mining ironstone by driving drifts into the hillside, instead of sinking shafts. (Gresley)

Under-level drift (Eng.). A drift from a pumping pit, to free dip workings from water. (Bainbridge)

Underlie. 1. (Corn.). *See* Underlay, 1 and 2.
2. In geology, to occupy a lower position than, or to pass beneath; said of stratified rocks over which other rocks are spread out. (Century)

Underlier (Eng.). *See* Underlay shaft.

Underlooker (Lanc.). One who has the care and superintendence of the miners and of the workings, who receives his orders from the manager, and to whom the overmen and deputies report; a mine superintendent. (Gresley)

Underlying. Lying under or beneath; fundamental; as underlying strata. (Webster)

Undermine. To excavate the earth beneath, or under part of; to form a mine under (Webster). *See* Undercut; Underhole.

Underpinning. 1. Building up the wall of a mine-shaft to join that above it. (Gresley)
2. The act of supporting a superior part of a wall, etc., by introducing a support beneath it. 3. A solid structure, as a new foundation or other support. (Century)

Under-poled. A term used in copper refining to designate copper not poled enough to remove all suboxide, and which has solidified with a concave surface. *See* Overpoled and Tough pitch.

Underply (Scot.). A band or division of the lower portion of a thick seam of coal. *See* Mining ply.

Under reamer. An oil-well tool used for enlarging the hole below a drive shoe, etc. (Nat. Tube Co.)

Under seams (Scot.). Lower or deeper coal seams. (Gresley)

Under-shot wheel. A wheel moved by water passing underneath. (Webster)

Undersize. That part of a crushed material which passes through a screen.

Under the top (Eng.). A road in which a layer of coal is left standing to form the roof is said to be "under the top." (Redmayne)

Underthrust. In geology, a deformation produced on immediately underlying strata by an advancing overthrust mass. It may be a forward movement in a parallel thrust plane, or an overturning or crushing of the strata. (Standard)

Underviewer; Underlooker (Eng.). In coal mining, an underground foreman; in metal mining, a mining captain.

Underweight (Aust.). The weight of the roof which advances along the face of the coal, following the process of undercutting, in longwall work, and breaks down the portion that has been undercut.

Undisturbed. Rocks that lie in the positions in which they were originally formed. *Compare* Disturbed. (Roy. Com.)

Undulating. Rising and falling like waves. Said of beds that are bent into alternate elevations and depressions.

Unholed (York.). Bordgates or other headings not driven through into the adjoining roadway. (Gresley)

Uniaxial. Having but one direction in which light passing through the crystal is not doubly refracted. (La Forge)

Unicline. Sloping in one direction; a monoclinal.

Unión (Sp.). Coupling of wire rope or of pipe. (Dwight)

Union shop. A shop or mine run according to the requirements of a trade-union. *Compare* Open shop.

Unisilicate. In mineralogy, a salt of orthosilicic acid. (Standard)

Unit. 1. Any determinate amount or quantity (as of length, time, heat, value, etc.) adopted as standard of measurements for other amounts of the same kind. (Webster)
2. A term used in smelter settlements for valuable contents of ores and is equivalent to 1 per cent of a short ton, or 20 pounds. (Lindgren, p. 17)

Univalent. Having a valence of one; monovalent. (Webster)

Universal lay. *See* Lang lay rope.

Universal train. A roll train having adjustable horizontal and vertical rolls, so as to produce sections of various sizes. (Raymond)

Unkindly lode (Aust.). A lode or vein that does not look promising. (Power)

Unlimited pump. A deep-well pump operated from the level of the ground above. (Standard)

Unpatented claims. Mining claims to which a deed from United States Government has not been received. The claims are subject to annual assessment work, in order to maintain ownership. (Weed)

Unscreened coal (Aust.). Run-of-mine coal. (Power)

Unsoiling. The act or process of removing soil, as for working a bed of brick clay. (Standard)

Unsoundness. A quarry term that refers to all cracks or lines of weakness other than bedding planes that may cause rock to break before or during the process of manufacture. Various types of unsoundness are known locally as "joints," "headers," "cutters," "hair lines," "slicks," "seams," "slick seams," "dry seams," "dries," and "cracks." (Bowles)

Unstratified. Not formed or deposited in beds or strata. (La Forge)

Unwater. To pump water from mines. (Gresley)

Unwrought; Unworked (Eng.). Coal or other mineral which has not been mined or worked away. (Gresley)

Up. 1. (Eng.) A stall or heading is said to be *up* when it is driven or worked up to a certain line (a fault, hollows, boundary, etc.), beyond which nothing further is to be worked. 2. (Eng.) On the bank or on the surface. (Gresley)

Up-brow (Lanc.). An inclined plane worked to the rise. (Gresley)

Upcast. 1. The opening through which the return air ascends and is removed from the mine (Gresley). The opposite of downcast or intake.
2. An upward current of air passing through a shaft, or the like. (Century)
3. To cast or throw upward; to turn upward. (Webster)
4. In geology, same as *upthrow;* opposed to *downthrow, downcast;* as, the *upcast* side of a fault. (Standard)

Upcast shaft. *See* Upcast, 1.

Upcast pit (Newc.). The shaft up which the air ascends when ventilating the mine (Min. Jour.). *See* Upcast, 1.

Updraft kiln. A kiln in which the heat enters the chamber from the bottom and passes up through the ware. (Ries)

Upheaval. A lifting up, as if by some force from below, of stratified or other rocks. (Roy. Com.)

U-pipe stove. A common type of heat-recuperation furnace. (Ingalls, p. 361)

Up-leap (Mid.). A fault which appears as an upthrow. (Gresley)

Uplift. Elevation of any extensive part of the earth's surface relatively to some other part; opposed to Subsidence. (La Forge)

Up-over. Designating a method of shaft excavation by drifting to a point below, and then raising instead of sinking. (Webster)

Up-over crib. A wedging crib placed on the top of a length of tubing, to shut off the water in a certain stratum. (Gresley)

Upper. 1. A drill hole driven in an upward direction (H. C. Hoover, p. 100).

2. In geology, designating a later period or formation; so called because the strata are normally above those of the earlier formations. (Webster)

Upper barren coal measures. The part of the Carboniferous strata of the Appalachian field which is now assigned to the Dunkard group of the Permian series. Usage now obsolete. (La Forge)

Upper leaf (Scot.). The upper portion of a seam that is separated, by a parting, into two portions. (Barrowman)

Upper productive coal measures. The part of the Carboniferous strata of the Appalachian field which is now assigned to the Monongahela group of the Pennsylvanian series. Usage now obsolete. (La Forge)

Upraise. An auxiliary shaft, a mill hole, carried from one level up toward another (Ihlseng). *See* Rise, *also* Raise, which are better terms.

Upset. 1. To increase the diameter of a rock drill by blunting the end. (Gillette, p. 52)
2. (Scot.) A narrow heading connecting two levels in inclined coal (Gresley). Sometimes used as a synonym for Raise.
3. (Aust.) A capsized or broken skip. (Power)

Upstanders (Corn.). Pieces of timber or boards fixed in the ground at a prospect shaft, to support the axletree or windlass. (Pryce)

Upstanding (Scot.). A term applied to stoop-and-room workings to denote that the pillars are in a sound condition and the roof not fallen. (Barrowman)

Up stoop (Scot.). A working room is *up stoop* or *in stoop* when its length is equal to the side of the pillar to be formed. (Barrowman)

Upthrow. The block or mass of rock on that side of a fault which has been displaced relatively upward. (La Forge). The term should be used with the definite understanding that it refers merely to a relative and not an absolute displacement.

Upthrust. An upheaval of rocks; said preferably of a violent upheaval; used also attributively. (Standard)

Uraconite. An amorphous, earthy, lemon-yellow, hydrous uranium sulphate. Uranium ocher. (Standard)

Uralite. A fibrous or acicular variety of hornblende occurring in altered rocks and pseudomorphous after pyroxene (La Forge). The word is often used as a prefix before the names of those rocks that contain the mineral. The name is derived from the original occurrence in the Urals. (Kemp)
2. A trade name for a fireproof material, chiefly of asbestos. (Webster)

Uralitization. The change of the mineral augite into the green fibrous variety of the mineral hornblende. The change is often due to weathering, but may be a result of more intense metamorphism. (Ransome)

Uranic ocher. Same as Uraconite, (Standard)

Uraninite. A complex uranium mineral containing also rare earth, radium, lead, helium, nitrogen, and other elements. Uraninite in the stricter sense is applied to crystallized forms found in pegmatites. It contains Th, Ce, La, and Yt. The mineral found in Connecticut and North Carolina is of this variety. Pitchblende is the massive form, probably amorphous, and contains no thoria, but a specimen from Gilpin County, Colo., contained 7.6 per cent zirconia. Pitchblende is found in metalliferous veins with sulphides. Both varieties contain radium. Contains from 65 to 90.7 per cent of the combined oxides UO_3 and UO_2. *See also* Nivenite. (U. S. Geol. Surv.)

Uranic (Sp.). 1. Uranium. 2. Uranium ore. (Halse)

Uranite. A general term for the uranium phosphates, autunite, or calcium uranite, and torbernite, or copper uranite, formerly classed as single species. The uranite group includes these and a few related minerals. (Webster)

Uranium. An element of the chromium group, found in combination in pitchblende and contains other rare minerals. When reduced it is a heavy, hard, nickel-white metal. Symbol, U; atomic weight, 238.2; specific gravity, 18.7. (Webster)

Uranium minerals. *See* Autunite, Carnotite, Fergusonite, Mackintoshite, Nivenite, Polycrase, Samarskite, Thorianite, Thorogummite, Torbernite, Uraninite (including Pitchblende), Uranocircite, Uranophane, Uranospinite, Yttrialite. Uranium is not found native. All uranium minerals contain radium. (U. S. Geol. Surv.)

Uran-mica. Same as Uranite. (Century)

Uranocircite. A hydrous phosphate of uranium and barium, $Ba(UO_2)_2P_2O_8+8H_2O$. (U. S. Geol. Surv.)

Uranolite. A meteorite. (Century)

Uranophane. A hydrous silicate of uranium and calcium, $CaSiO_3.UO_3SiO_3+6H_2O$. (U. S. Geol. Surv.

Uranorthorite. A variety of thorium silicate; thorite containing a small percentage of oxide of uranium. (Century)

Uranospinite. Probably an arsenate of uranium and calcium corresponding to autunite. $Ca(UO_2)_2As_2O_8+8H_2O$. Contains about 47.6 per cent uranium, equivalent to 56.1 per cent calculated as U_3O_8. (U. S. Geol. Surv.)

Urao. Hydrous sodium carbonate, $Na_2CO_3.NaHCO_3+2H_2O$. Trona is an impure form of urao. (U. S. Geol. Surv.)

Ure's process. The treatment of quicksilver ores by heating in iron retorts with admixture of lime. (Raymond)

Urgonian. In geology, a division of the European Lower Cretaceous characteristically developed in certain parts of France and Belgium. (Standard)

Urgue (Colom.). 1. Clay. 2. A clay band separating the vein from the wall. (Halse)

Urpethite. A yellowish-brown to to brown hydrocarbon, near ozocerite. (Standard)

Urry (local Eng.). A blue to black clay found next to coal in coal mines. (Standard)

Urtite. A name given by W. Ramsay to a light-colored rock of medium grain, consisting of nephelite in largest part, with which is considerable ægirite and a little apatite. When recast an analysis gave nephelite, 82; ægirite, 16; apatite, 2. The name is derived from the second part of Lujavr-Urt, the name of the mountain where it occurs in northern Finland. (Kemp)

Utahite. An orange-yellow iron sulphate mineral, $3Fe_2O_3.3SO_3.4H_2O$, from the Tintic district, Utah. Has a silky luster (Dana)

Utahlite. *See* Variscite.

Utilites. A general term proposed by M. E. Wadsworth for all useful geological products. His subdivisions according to uses are: *Ceramites*, fictile or ceramic materials. *Chalicites*, binding materials or limes, mortars, cements, etc. *Chemites*, chemical materials. *Chromatites*, color materials or paints, pigments, etc. *Coprites*, fertilizers or mineral manures. *Cosmites*, Decorative materials, or ornamental stones and gems. *Ignites*, pyrotechnic materials. *Lubricites*, lubricants, or friction materials. *Metallites*, ores or metalliferous materials. *Pharmacites*, mineral medicines. *Pyrolites*, refractory or fire resisting materials. *Rholites*, smelting materials, or fluxes. *Salites*, salts and saline materials. *Techtonites*, construction materials, as building and road materials. *Thermites*, fuels or burning materials, or *carbonites*. *Tribolites*, abrasives, or attrition materials. *Vitrites*, vitrifying materials, or glass, etc. (Eng. and Min. Jour., vol. 58, p. 340). These terms are not used.

Uvarovite; Ouvarovite; Uwarowit. Calcium-chromium garnet, $3CaO.Cr_2O_3.3SiO_2$. Aluminum takes the place of chromium in part. (Dana)

Uwarowit. *See* Uvarovite.

V.

Vaciadero (Sp.). A waste dump; a spoil bank. (Halse)

Vaciador (Mex.). One who dumps slag pots. (Dwight)

Vacio (Sp.). Empty; a vacuum. (Halse)

Vacuum. 1. A space entirely devoid of matter. 2. The degree of rarefaction of a partial vacuum, measured by the reduction of pressure from that of the atmosphere. (Webster) 3. A method of producing ventilation by exhausting the air from the mine. (Gresley)

Vacuum fan. A fan for creating suction or partial vacuum (Webster). An exhaust fan. *See* Vacuum, 3.

Vacuum filter. A form of filter in which the air beneath the filtering material is exhausted to hasten the process. (Century)

Vacuum pump. 1. A pump in which water is forced up a pipe by the difference of pressure between the atmosphere and a partial vacuum. 2. A pump for creating a partial vacuum in a closed space (Webster). *See* Pulsometer.

Vacuum tube. A sealed tube containing highly rarefied air or other gas, for exhibition or examination of phenomena of electric discharge between metallic electrodes projecting into the tube from the outside. (Webster)

Vadose. Extending only a short depth below the surface: said of the shallower portion of the ground water. (La Forge)

Vag (Prov. Eng.). Dried peat or turf used for fuel. (Standard)

Vagón (Sp.). A wagon; *V. de volquete, ó volteo*, a dump car; *V. de pico*, a front or side dump car. (Halse)

Vagoneta (Sp.). 1. A small open car. 2. A trolley. 3. The bucket of a rope way. (Halse)

Vaguada (Sp.). 1. Water way or stream channel. 2. Water shed or divide. (Dwight)
3. The line of intersection of two opposite slopes. (Halse).

Vale; Val. (Corn.). The place where the reserve of tin ore is placed to dry before it is put into the smelting furnace. (Davies)

Valence. The degree of combining power of an element (or radical) as shown by the number of atomic weights of hydrogen, chlorine, sodium or the like, with which the atomic weight of the element will combine, or for which it can be substituted, or with which it can be compared. (Webster)

Valencianite. An orthoclase feldspar similar to adularia, from Valencia, Mexico. (Webster)

Valentinite. Antimony trioxide Sb_2O_3, in orthorhombic crystals. (Dana)

Valle (Mex.). Valley. (Dwight)

Valley. 1. Low land bounded by hills or mountains. (Power)
2. A small, subcircular basin, eroded by solution in the crest of an uplift, and having a sink through which its sediments escape; used locally in Missouri and vicinity. (Standard)

Valley brown ore. A local name for limonite or brown iron ore. Applied in Virginia to the comparatively pure high-grade ore found in the Cambro-Ordovician limestone which forms the Valley of Virginia. *See* Mountain brown ore. (U. S. Geol. Surv.)

Valley glacier. A glacier extending into a valley (Chamberlin, vol. 1, p. 239). A glacier which occupies a valley and is fed from a névé reservoir. (Century)

Valley tile. Roofing tile made to fit in the valley of a roof. (Ries)

Valley train. A deposit of glacial outwash forming an old flood plain in a valley. (La Forge)

Valuation. 1. The act of valuing, or of estimating the value or worth; appraisement. 2. Value set upon a thing. (Webster)

Value. (1) The desirability or worth of a thing as compared with the desirability of something else; worth (Standard), as the *value* of a mine. Value is an attribute, and not a substance.
(2) In the plural, as used in mining and metallurgy, the valuable ingredients to be obtained, by treatment, from any mass or compound; specifically, the precious metals contained in rock, gravel or the like, as the vein carries good *values*; the *values* on the hanging wall. (Webster)
(3) To estimate or determine the worth of anything, as to *value* a mine.

Valve. Any contrivance, as a lid, cover, ball, or slide, that opens and closes a passage, whether by lifting and falling, sliding, swinging, or rotating, as at the opening of, or inserted in, any pipe, tube, outlet, inlet, etc., to control the flow or supply of liquids, gases, or other shifting material. (Standard)

Válvula (Sp.). Valve; *V. de seguridad*, a safety valve. (Halse)

Vamos (Sp.). To depart quickly; to decamp. (Vel.)

Vamping. The débris of a stope, which forms a hard mass under the feet of the miner. (Raymond)

Van. 1. (Corn.) A test of the value of an ore, made by washing (vanning) a small quantity, after powdering it, on the point of a shovel. Vanning is to a Cornish miner what washing in a horn spoon is to the Mexican. 2. To separate, as ore from veinstone, by washing it on the point of a shovel. *See* Vanner. (Century). 3. A shovel used in ore dressing.

Vanadic ocher. A native yellow vanadium oxide found near Lake Superior. (Standard)

Vanadinite. Lead chlorvanadate, $3Pb_3V_2O_8.PbCl_2$. Contains when pure 19.4 per cent V_2O_5, but arsenic and phosphorus both replace vanadium, so that the mineral grades into mimetite, $3Pb_3As_2O_8.PbCl_2$, and into pyromorphite, $3Pb_3P_2O_8.PbCl_2$. Endlichite is a variety of vanadinite containing considerable arsenic. (U. S. Geol. Surv.)

Vanadium. A rare element found combined, in certain minerals (as vanadinite and descloizite) and is reduced as a grayish white metallic powder. Symbol, V; atomic weight, 51.0; specific gravity, 5.5. (Webster)

Vanadium ores. Vanadium does not occur native, but is found in the United States in the minerals carnotite, roscoelite, vanadinite, descloizite, volborthite, calciovolborthite, and ægirite. (U. S. Geol. Surv.)

Vanadium steel. Steel alloyed with vanadium (usually 0.10 to 0.15 per cent), an element which strengthens the steel and serves to remove the oxygen and possibly nitrogen. (Webster)

Vandyke brown. A deep brown pigment of uncertain identity, used by the painter Van Dyck; hence any of various brown pigments, as a natural earth resembling amber, a preparation of charred cork, a mixture of lamp black and Indian red, etc. (Webster)

Vane. In surveying, the target of a leveling staff; one of the sights of a compass, quadrant, etc. (Webster)

Vanner. 1. A machine for dressing ore; an ore-separator; a vanning machine. The name is given to various patented devices in which the peculiar motions of the shovel in the miner's hands in the operation of making a van (*see* Van, 1) are, or are supposed to be, more or less successfully imitated (Century). *See* Frue vanner for general description of the side-shake type. There is also an end-shake type, which includes the Triumph concentrator.
2. One who vans with a shovel or pan (Webster), or one who operates a vanning machine.

Vanning (Corn.). *See* Van, 2.

Vanning machine. *See* Vanner, 1.

Vapart mill. A centrifugal grinder for pulverizing ore, coal and coke. (Ingalls, p. 509)

Vapor. 1. Any visible diffused substance floating in the air and impairing its transparency, as smoke, fog, etc. 2. Any substance in the gaseous state, thought of with some reference to the liquid or solid form; a gasified liquid or solid. (Webster) 3. Foul air in a mine. (Lawver)

Vapor density. The relative weight of a gas or vapor as compared with some specific standard, usually hydrogen, but sometimes air. (Webster)

Vapor galvanizing. A process for coating metal (usually iron or steel) surface with zinc by exposing them to the vapor of zinc instead of, as in ordinary galvanizing, to molten zinc. Also called Sherardizing. (Webster)

Vaporimeter. An instrument for measuring the volume or the tension of a vapor. (Webster)

Vara (Sp.). A Spanish and Portuguese measure of length. In Mexico it is 33 inches; Brazil, 43 inches; Colombia, 31.5 inches; Central America, 33.87 inches; Spain, Cuba, Philippine Islands, and Venezuela, 33.38 inches; Chile, and Peru, 33.37 inches; Argentina and Paraguay, 34.12 inches. (Webster)

Varejón (Mex.). Pole lagging. (Dwight)

Variation. The angle by which the compass needle deviates from the true north: subject to annual, diurnal, and secular changes. Called more properly *declination of the needle* (Standard). *See* Declination.

Variation compass. A compass of delicate construction for observing the variation of the magnetic needle. (Webster)

Variegated copper ore. Bornite.

Variegated sandstone. New red sandstone. (Standard)

Varigradation. In geology, a process by which all streams of progressively increasing volume tend constantly, in a degree varying inversely with the volume, to depart slightly from the normal gradients. (Standard)

Varilla (Sp.). 1. A boring rod. 2. A blasting needle. 3. A spindle or pivot. (Halse)

Variole. In petrology, a spherulite or variolite. (Standard)

Variolite. A spherulitic variety of basalt or diabase (La Forge). The rock has a pockmarked aspect and hence the name, which is a very old one. Pearl diabase is synonymous. (Kemp)

Variolitic. Of, pertaining to, or resembling variolite. (Webster)

Variolitization. That variety of contact metamorphism, that gives rise to the formation of variolite. (Standard)

Variscite; Utahlite. Green hydrous phosphate of aluminum, $Al_2O_3.P_2O_5.4H_2O$. Used as a gem (U. S. Geol. Surv.). Also called Amatrice.

Varnish. In ceramics, the lustrous surface or glaze on pottery, porcelain, etc. (Standard)

Vaseline; Vaselin. A yellowish, translucent, semisolid petroleum product, used in ointments and pomades, as a lubricant, and in other ways; a form of petrolatum. (Webster)

Vaso (Sp.). 1. A vessel. 2. (Mex.) A small adobe furnace lined with clay. 3. The shaft of a furnace. 4. The crucible of a blast furnace. 5. (Mex.) A receptacle for molten metal in front of a furnace. (Halse) 6. (Mex.) Reverberatory for smelting rich ore, or for cupelling silver. (Dwight)

Vat. 1. A vessel or tub in which ore is washed or subjected to chemical treatment, as "cyanide vat" and "chlorination vat" (Rickard). Used as synonym for Tank. 2. *See* Vate.

Vate (Corn.). A square, hollow place on the back of a calcining furnace for drying tin ore before feeding it into the furnace. Also spelled Vat. (Pryce)

V-bob. A strong frame shaped like an isosceles triangle, and turning on a pivot at its apex; used as a bell crank to change the direction of a main rod (Webster). It is used with Cornish pumping engines.

V-cut. In mining and tunneling, a cut where the material blasted out in plan is like the letter V; usually consists of six or eight holes drilled into the face, half of which form an acute angle with the other half. (Du Pont)

Veal; Voun (Scot.). A water box or chest, usually on wheels, for removing water (Barrowman). Also called Ghost.

Vee (Mid.). The junction of two underground roadways meeting in the form of a V. (Gresley)

Veerer (Som.). An old word for banksman. (Gresley)

Vees; Veez. 1. (Scot.) A kind of soft earth in a fissure or upon the sides of a dike. *See* Leatherbed. (Gresley)
2. (Scot.) The line of fracture of a fault or hitch. (Barrowman)

Vegetate. To crystallize; to exude. (Lawver)

Vegetation of salts. A crystalline concretion formed by salts, after solution in water, when set in the air for evaporation. Also called Saline vegetation. (Century)

Veia (Port.). 1. A vein. 2. *Veias* (Braz.). Ordinary plaster beds (Halse). *See* Vena, Veta, and Filon.

Vein. 1. An occurrence of ore, usually disseminated through a gangue, or veinstone, and having a more or less regular development in length, width, and depth. A vein and a lode are, in common usage, essentialy the same thing, the former being rather the scientific, the latter the miners', name for it (Century). See Lode; Fissure; Fissure vein.
The filling of a fissure or fault in a rock, particularly if deposited by aqueous solutions. When metalliferous it is called by miners a *lode;* when filled with eruption material, a *dike.* A bed or shoot of ore parallel with the bedding. Called also Blanket-deposit. (Standard)
A crack in rock filled by mineral matter deposited from solution by underground water. A lode. (Webster)
A *vein* or *lode* as used in the law applies to any zone or belt of mineralized rock lying within boundaries clearly separating it from the neighboring rock. (Iron Silver Mining Co. v. Cheeseman, 116 United States, p. 531; Mammoth Mining Co. v. Grand Central Mining Co., 213 United States, p. 77.)
Vein or lode does not mean merely a typical fissure or contact vein, but any fairly well-defined zone, or belt of mineral-bearing rock in place. (East Tintic Cons. Min. Claim, In re, 50 Land Decisions, p. 273)
2. A comparatively thin sheet of igneous rock injected into a crevice in rock. When this intrusion is large it is called a dike. (Webster)

Vein (or lode) claim. The terms "vein or lode" and "vein or lode claim" are used indiscriminately and interchangeably, and it follows that the term "vein or lode" is intended to be synonymous with the term "vein or lode claims." (Iron Silver Mining Co. *v.* Sullivan, 16 Fed. Rept., p. 832). *See* Vein; *also* Lode. (*Also* U. S. Min. Stat., pp. 37–43)

Veined. Marked or streaked with veins or lines of color in various directions, as some marbles. (Roy. Com.)

Vein minerals. The minerals occurring in veins, especially the gangue (A. F. Rogers.) Veinstone.

Vein quartz. Quartz of secondary origin and occurring in veins. (Standard)

Vein skirts (Derb.). The walls of a lode. (Power)

Veinstone. The mineral-matter filling of a vein, exclusive of the ore (Roy. Com.). Also called gangue; Lodestuff, Matrix, Vein mineral.

Veinstuff. The portion of the lode which is not ore (Skinner). *See* Veinstone.

Vein system. A term applied to the veins of a given area, district, or age, regarded as a whole. (Farrell)

Veise (Scot.). A joint in the coal strata. (Gresley) *See* Vees, 1.

Vela (Sp.). 1. A watchman; night guard. 2. A candle; *V. de sereno*, a wax candle; *V. de sebo*, a tallow candle. (Halse)

Velada. (Colom.) The third part of the night during which a watchman is employed in the mill to see that the blanketings are not stolen.

Velador (Sp.). 1. A watchman at the mines or mill. 2. A candleholder. (Halse)

Veldt (So. Afr.). A tract of land not forested, or thinly forested; a grass country. (Webster)

Velocity-head. The constant difference of height of a liquid between a level surface in a tank and a uniformly flowing jet through an orifice. (Standard)

Velocity of detonation. The velocity with which the detonation or explosion of a mass of explosives travels through the mass itself. (Du Pont)

Velvet. Profit; easily earned money. By analogy, a term used for galena in the Wisconsin zinc field when it can be separated from the blende without difficulty and sold as a by-product.

Velvet copper ore. Lettsomite. Perhaps $4CuO.Al_2O_3.SO_3.8H_2O$, in velvet-like druses; in spherical forms; bright blue. (Dana)

Vena (Sp.). 1. A small metalliferous vein; a veinlet, not over 3 inches thick; a "knife blade" vein (Dwight). Sometimes a vein within a vein. *Compare* Veta and Filón.
2. A bed or seam of compact earthy red hematite at Bilboa, Spain. 3. Diverse quality or color of earth or stone. 4. A streak, stripe, or vein of a certain color in stone or wood. 5. A channel through which underground water circulates. 6. Mineral water found underground. 7. (Fr. Guiana). The richest gravel in placer mines. (Halse)

Venanzite. A name proposed by Sabatini, an Italian petrographer, for an effusive rock from a small volcanic cone at San Venanzo, Umbria, Italy. Venanzite contains phenocrysts of olivine in a groundmass of melilite, leucite, and black mica, together with a little pyroxene, nephelite, and magnetite. Rosenbusch subsequently described the same rock under the name euktolite, but venanzite has priority. (Kemp)

Vend (Newc.). The total annual sales of coal from a colliery. (Raymond)

Veneer. In ceramics, any thin outer coating put on principally for appearance or decoration. (Standard)

Venero. 1. (Mex.) A spring of water in a mine. 2. (Colom.) A vein or bed. 3. (Arg.) A deep-seated deposit covered by large masses of barren material. 4. (Bol.) A stream-tin deposit. 5. (Peru) The pay gravel of recent placers. 6. Any mineral deposit. (Halse)

Venetian chalk. A white compact talc or steatite used for marking on cloth. (Webster)

Venetian white. A pigment consisting of a mixture of equal parts of white lead and barite. (Webster)

Venida (Mex.). A fall of earth or stones, as from a hill. (Halse)

Venilla (Sp.). A small vein or stringer. *Compare* Vena, 1. (Halse)

Vent. 1. A small aperture; a hole or opening for passage or escape, as of air, a gas, or a fluid; a volcanic vent. (Webster)
2. (Scot.) A chimney; a return airway. (Barrowman)
3. A small passage made with a needle through the stemming, for admitting a squib to enable the charge to be lighted. (Steel) 4. In founding, an opening or passage, as in a sand-mold, for the escape of gases. (Standard)

Venta (Sp.). Sale. (Dwight)

Ventanilla. 1. (Sp.) A small window. 2. (Mex.) A flat or station. 3. An opening in the door of an ore chute, sliding gate, etc., for a rope to pass through. 4. (Peru) A natural opening in rocks. (Halse)

Ventanillero (Mex.). An underground station tender. (Dwight)

Ventilación (Sp.). Ventilation; *V. artificial*, artificial ventilation; *V. diagonal*, ventilation by two shafts situated at either end of a field of exploitation; *V. natural*, natural ventilation. (Halse)

Ventilador (Sp.). A ventilator, usually some kind of fan; *V. aspirante*, an exhaust fan; *V. soplante*, a blower. (Halse)

Ventilar (Sp.). To ventilate; *V. una mina*, to ventilate a mine. (Halse)

Ventilate. 1. To cause fresh air to circulate through (to replace foul air simultaneously removed), as a room, mine, etc. 2. To provide with a vent or escape for air, gas, etc. (Webster)

Ventilating column. *See* Motive column.

Ventilating pressure. The total pressure or force required to overcome the friction of the air in mines; viz: the pressure per square foot multiplied by the cross-sectional area of the airway.

Ventilation. 1. The atmospheric air circulating in a mine. 2. The art or method of producing, distributing, maintaining, conducting, and regulating a constant current or flow of atmospheric air in mine shafts, levels, inclines, etc. (Gresley)

Ventilator. 1. A mechanical apparatus for producing a current of air underground (Gresley). As a blowing or exhaust fan.
2. A furnace for ventilating a mine by heating the upcast air.

Venturi meter. A water meter in which the flow is ascertained from the increase in velocity and consequent loss of pressure caused by the reduction in the cross-sectional area of the pipe through which the water flows. (Webster)

Venturin. A yellow powder used as an imitation of gold in japanning (Standard). *Compare* Aventurine.

Venturi tube. A conical efflux tube in which the escaping fluid flows from the smaller to the large end, and the entrance is rounded to conform to shape of the *vena contracta*. (Webster)

Vent wire. A wire used by founders to make a hole in a sand mold for the escape of air or gases. (Standard)

Venule. A small vein; veinlet. (Standard)

Venus's hair-stone. Quartz containing included acicular crystals of rutile (Standard). *See* Sagenitic quartz.

Verandeador (Colom.). An alluvial miner who works in the dry season. (Lucas)

Veraneo (Colom.). Working in alluvial mines in the dry season. (Halse)

Verano (Sp. Am.). Summer. The dry season. (Halse)

Verde (Sp.). 1. Green. 2. Verdigris. (Halse)

Verde antique. A dark-green rock composed essentially of serpentine (hydrous magnesium silicate). Usually crisscrossed with white veinlets of magnesium and calcium carbonates. Used as an ornamental stone. In commerce often classed as a marble. (U. S. Geol. Surv.)

Verde di Corsica duro (It.). A rock found on the Island of Corsica, of a changing green color, composed of diallage and labrador feldspar, and used for vases, inlaying, and other ornamental purposes. (Page)

Verde salt. *See* Thenardite.

Verdigris. A green, or greenish-blue, poisonous pigment and drug, obtained by the action of acetic acid on copper, consisting of one or more basic acetates of copper. (Webster). The green rust on copper.

Verdiones (Chile). Green stains indicative of the presence of copper. (Halse)

Verditer. 1. Verdigris 2. Either of two basic carbonates of copper used as pigments, and prepared either by grinding the mineral azurite (giving blue verditer) and the mineral malachite (giving green verditer) or artificially. (Webster)

Verifier. 1. A tool used in deep boring for detaching and bringing to the surface portions of the wall of the bore-hole at any desired depth. (Raymond)
2. In gas testing, an apparatus by which the amount of gas required to produce a flame of a given size is measured; a gas verifier. (Standard)

Verite. A glassy variety of the mica-andesites with exceptional olivine. A name derived from the Spanish locality Vera, near Cabo de Gata, and given by Osann to a post-Pliocene glassy rock, with phenocrysts of biotite and microscopic crystals of olivine and augite and sometimes plagioclase, all of which seldom form half the mass of the rock. (Kemp)

Vermiculites. In mineralogy, a group including a number of micaceous minerals, all hydrated silicates; in part closely related to the chlorites, but varying somewhat widely in composition. They are alteration-products chiefly of the micas, biotite, phlogopite, etc., and retain more or less perfectly the micaceous cleavage, and often show the negative optical character and small axial angle of the original species. Many of them are of a more or less indefinite chemical nature, and the composition varies with that of the original mineral and with the degree of alteration. The laminae in general are soft, pliable, and inelastic; the luster pearly or bronze-like, and the color varies from white to yellow and brown. The minerals included are: Jefferisite, vermiculite, culsageeite, kerrite, lennilite, hallite, philadelphite, vaalite, maconite, dudleyite, pyrosclerite. (Dana)

Vermillion. 1. A bright red pigment consisting of the sulphide of mercury. *See* Cinnabar. (Roy. Com.)
2. (Lake Sup.) The lowest of the stratified schists; the crystalline schists. (Winchell)

Vermilionette. A substitute for the pigment vermilion, made by precipitating eosin or a similar dye upon a white base, as barium sulphate, or on a mixture of this with orange lead. (Webster)

Vernier. A small movable auxiliary scale for obtaining fractional parts of the subdivisions of a fixed scale, as on any instrument of precision. (Standard)

Vernier compass (Scot.). A mining compass for measuring angles without the use of the magnetic needle. (Barrowman)

Versant. One side or slope of a mountain range; as, the east *versant*. (Ransome)

Verst (Russ.). A Russian measure of length equal to 0.6629 mi. or 1.067 km. (Webster)

Vertedero (Sp. Am.). 1. A spring; rivulet; ravine. (Lucas)
2. The overflow of a dam (Halse). A spillway.

Vertical fault. *See* Fault.

Vertical shaft. A shaft sunk at an angle of 90° with the horizon, or directly downward toward the center of the earth. (Weed)

Vertical shift. The vertical component of the shift. *See* Shift, 4. (Lindgren, p. 122)

Vértice (Sp.). Vertex. (Dwight)

Vertiente (Sp.). 1. Watershed. (Dwight)
2. A waterfall. 3. A spring. 4. A waste weir of a dam. 5. An air vent. (Halse)

Vesicle. A small cavity in an aphanitic or glassy igneous rock, formed by the expansion of a bubble of gas or steam during the solidification of the rock. (La Forge)

Vesicular. Characteristic of or characterized by, pertaining to, or containing vesicles. (La Forge)

Vespertine. In geology, the tenth series of the Pennsylvania system of stratigraphy, comprising the Pocono sandstone of the Lower Carboniferous (Standard). Long obsolete.

Vestigio (Mex.). A trace of gold or silver in assaying. (Dwight)

Vestry. 1. (Eng.) The productive part of the vein. *See* Carbona; also Bowse. (Hunt)
2. (Newc.) Refuse. (Raymond)

Vesuvian garnet. An early name for leucite, from Vesuvius, its principal locality. (Chester)

Vesuvianite. A complex calcium-aluminum silicate of uncertain formula. A massive light-green variety is known as californite (U. S. Geol. Surv.). Also called Idocrase.

Vesuvius salt. Same as Aphthitalite. (Standard)

Veszelyite. A greenish-blue hydrous phospho-arsenate of copper and zinc. (Standard)

Veta (Sp.). Strictly a fissure-vein; loosely, any mineral deposit. A main vein. Compare *Vena* and *Filón*. *V. ahogada*, a drowned lode. *V. clavada*, a vertical vein. *V. corrida*, a continuous vein. *V. crucera*, a cross-vein. *V. cruzada*, a dislocated lode. *V. de cajón*, an incline lode. *V. de cuarzo*, a reef. *V. de hoyada*, a lode worked by Indians. *V. de manto*, a horizontal lode. *V. de resbalon*, a vertical lode. *V. de sombre*, floor; horizontal lode. *V. echada*, an inclined vein. *V. en borra*, a vein carrying no ore. *V. en cuña*, a gash vein. *V. filón*, a fissure vein. *V. en frutos*, a vein carrying pay ore. *V. madre*, the main lode; mother lode. *V. ramal*, a branch-vein. *V. rechazada*, dislocated lode. *V. recostada*, an inclined vein. *V. robada*, a spoiled lode. *V. seca*, a dry lode. *V. serpenteada*, a vein of variable strike. *V. socia*, a companion or connecting vein. (Dwight, Halse, Lucas)

Vetilla. 1. (Mex.) A slide. A groove in a slickenside (Dwight) 2. A veinlet. (Lucas)

Vezin's sampler. A mechanical sampling device that automatically selects one twenty-fifth or one sixty-forth of the ore passing through. (Hofman, p. 64)

V-flume. A V-shaped flume, supported by trestlework, and used by miners for bringing down timber and wood from the high mountains, at the same time using the water for mining purposes. Some of these flumes are many miles in length; one on the western slope of the Sierra Nevada mountains, in California, was over 40 miles long. (Crofutt)

Via (Sp.). 1. A road, a route. 2. An underground road, gallery or shaft. 3. An aerial ropeway; a cableway. 4. *V. vertical*, guides for a skip or cage. (Halse)

Vibracone. A vibrating ore-screen in which the feed is from a saucer-shaped distributer onto a conical surface kept in vibration by a ratchet motion. (Liddell)

Vicinal forms. In crystallography, forms taking the place of the simple fundamental forms to which they approximate very closely in angular position. Such forms are exceptional. (Dana)

Vielle-Montagne furnace. A mechanical roasting furnace similar to the Ross and Welter type. (Ingalls, p. 110)

Viewer (Eng.). A colliery manager or superintendent. (Chance)

Vignite. A magnetic iron ore. (Century)

Vigorite. An explosive resembling dynamite No. 2, and consisting of nitroglycerin with a more or less explosive dope. (Raymond)

Vigo's powder. Mercuric oxide. (Standard)

Vilanquis (Bol.). Ores containing native silver, chloride, sulphate, and oxide of silver. (Halse)

Vinney. Copper ore, with a green efflorescence like verdigris. (Davies)

Vintlite. A quartz-porphyrite occurring in dikes near Unter-Vintl, in the Tyrol. *Compare* Toellite from the same region. (Kemp)

Virgin. Applied to metals occurring elementally, as virgin gold, as distinguished from ore minerals which are chemical compounds (Weed). *See* Native.

Virgin clay. Fresh clay, as distinguished from that which has been fired. (Standard)

Virgin coal. A coal seam or part thereof in which no mining has been carried on.

Virgin field. A mineral field in which there has been no mining.

Virgin steel. A deceptive name given to articles made merely of good cast iron. (Century)

Viridite. A name suggested by Vogelsang and formerly used for the microscopic, green, chloritic scales often seen in thin sections. As their true nature has now been determined, they are generally called chlorite. (Kemp)

Viscosine. A Russian lubricating oil which possesses a specific gravity of 0.925 to 0.935, a flash point of 290° to 310° C., and an Engler viscosity of 5 minutes at 100° C. (Bacon)

Viscosity. The property of liquids that causes them to resist instantaneous change of shape or of the

arrangements of their parts; internal friction; gumminess. (Rickard) A term used in flotation processes.

Viscous. 1. Adhesive or sticky, and having a ropy or glutinous consistency. (Webster) 2. Imperfectly fluid; designating a substance that, like tar or wax, will change its form under the influence of a deforming force, but not instantly, as more perfect fluids appear to do. (Standard)

Visette (Fr.). A slope or incline. (Gresley)

Vista (Sp.). Sight; *mineral á la vista*, ore in sight. (Halse)

Viterio (Sp.). 1. Vitreous. 2. Glassy. (Halse)

Vitreous. Having the luster of broken glass, quartz, calcite. (Dana)

Vitreous copper. Chalcocite. (Power)

Vitreous fusion. Gradual fusion, not having a sharp melting point. (Webster)

Vitreous silver. Argentite. (Standard)

Vitrics. 1. Fused siliceous compounds, such as glasses and enamels, as distinguished from ceramics, or fused aluminous compounds. 2. The art or history of glass-production. (Standard)

Vitrifaction. *See* Vitrification.

Vitrifacture. The manufacture of vitreous or vitrified wares, as glass. (Standard)

Vitrifiable color. A metallic oxide mixed with glaze: used in ceramic color-decoration. (Standard)

Vitrification. Act, art, or process, of vitrifying; state of being vitrified; also a vitrified body. (Webster)

Vitrify. To convert into, or cause to resemble, glass or a glassy substance, by heat and fusion. (Webster)

Vitriol. 1. A sulphate of any of the various metals, as copper (blue vitriol), iron (green vitriol), zinc (white vitriol), etc. 2. Oil of vitriol, as sulphuric acid. 3. To dip in dilute sulphuric acid; to pickle. (Webster)

Vitriolate. To make into sulphuric acid or a sulphate. To subject to the action of, or impregnate with vitriol. (Webster)

Vitriolo (Sp.). Vitriol; *V. azul*, blue vitriol; *V. blanco*, white vitriol; *V. verde*, green vitriol; copperas. (Halse)

Vitriol ocher. Same as Glockerite. (Standard)

Vitriol of Mars. Same as Green vitriol. (Standard)

Vitrites. A word used by M. E. Wadsworth to include vitrifiable material, as glass, etc. (Power)

Vitro. A prefix meaning glassy and used before many rock names, as vitrophyre, in order to indicate a glassy texture. (Kemp)

Vitrophyre. Vogelsang's name for quartz-porphyries and porphyries with glassy groundmass (Kemp). *See* Felsophyre and Granophyre.

Vitrophyric. Porphyritic, with a glassy or vitreous base: said of the fabric of some igneous rocks. (La Forge)

Vivianite. A hydrous, ferrous phosphate, $Fe_3(PO_4)_2.8H_2O$, colorless when unaltered, or blue to green, growing darker on exposure (Webster). Called also Blue iron earth; Blue ocher.

"V-method" of roasting. The introduction of a supplementary roast heap between each two regular heaps, so that, if left untouched, there would be a continuous and unbroken roast heap the entire length of the roast yard. (Peters, p. 136)

Vogesite. A lamprophyric variety of syenite prophyry containing phenocrysts of hornblende, augite, or diopside. (La Forge)

Vogle. In mining, same as Vug. (Standard)

Voglianite. A soft, green, basic uranium-sulphate, found in nodules or as earthy coatings. (Standard)

Voglite. A hydrous carbonate of uranium, calcium, and copper. Color emerald-green to bright grass-green. (Dana)

Voladora. 1. (Peru) An upper millstone. 2. One of the grinding stones or mullers of an *arrastre*. (Dwight) 3. (Sp.) A fly wheel. (Halse)

Voladura (Sp.). A large blast. (Halse)

Volandera (Sp.). 1. The runner of a Chilian or edge-mill. 2. An upper mill stone. (Halse)

Volante (Sp.). A fly wheel; *V. de piedra*, a Chilian mill. (Halse)

Volar (Sp.). To blast rocks. Generally used for large blasts. (Halse)

Volatile. Easily wasting away by evaporation; readily vaporizable (Webster), *e. g.*, those fractions of bituminous materials which will evaporate at climatic temperatures. (Bacon)

Volatile combustible. That part of the combustible matter of coal which is driven off when the coal is heated in a closed vessel, chiefly compounds of hydrogen and carbon. (Steel)

Volborthite. A hydrous vanadate of copper, barium, and calcium. (U. S. Geol. Surv.)

Volcán. 1. (Sp.) Volcano. (Dwight) 2. (Colom.) A land slide. (Halse)

Volcanello. A small volcano, especially when connected with an active one. (Standard)

Volcanic. Characteristic of, pertaining to, situated in or upon, formed in, or derived from volcanoes. (La Forge)

Volcanic ash; Volcanic tuff. *See* Ash, *also* Tuff.

Volcanic bomb. *See* Bomb, 1.

Volcanic breccia. *See* Breccia.

Volcanic cone. A cone formed by volcanic discharges. (Standard)

Volcanic eruption. The breaking forth of lava, pumice, dust, etc., from the mouth of a volcano. (Standard)

Volcanic focus. The supposed seat or center of activity in a volcanic region or beneath a volcano. (Century)

Volcanic glass. A volcanic igneous rock of vitreous or glassy texture, such as obsidian, pitchstone, and tachylyte. (La Forge)

Volcanic mud. Mud formed of fine-grained tuff, either mixed with eruptive water and flowing from the volcano as mud, or erupted as dust and later mixed with surface water, generally rain falling on the slopes of the volcano. (La Forge)

Volcanic neck. The filled-up vent or pipe of a former volcano. (Standard)

Volcanic rock. Any rock of volcanic origin: volcanic igneous rocks are those erupted as molten masses, forming lava flows, dikes in the crater walls, volcanic plugs, etc.; volcanic sedimentary rocks are the fragmental materials ejected in explosive eruptions, forming tuff, agglomerate, etc. (La Forge)

Volcanic sand. Finely divided fragments of lava produced by volcanic explosions. (Standard)

Volcanic sink. A volcanic basin of engulfment, or down faulting, with a floor area many times greater than the cross section of the associated vent. (Daly, p. 152)

Volcanic tuff. *See* Tuff.

Volcanism. Volcanic power or activity. As used in physical geography and geology, the term ordinarily includes all natural processes resulting in forming volcanoes, lava fields, laccoliths, stocks, dikes, etc. (Webster)

Volcanist. One versed in the study of volcanic phenomena; also a Plutonist. (Webster)

Volcanite. A name proposed by W. H. Hobbs, for an anorthoclase-augite lava with the chemical composition of dacite. The name was suggested by the original occurrence on the island of Volcano, one of the Lipari group, where the rock is found as cellular bombs. (Kemp)

Volcanity. The state of being volcanic or of volcanic origin. (Century)

Volcanize. To subject to, or to cause to undergo and be affected by, volcanic heat. (Webster)

Volcano. A vent in the earth's crust communicating with a magmatic reservoir and commonly in the summit of a conical mountain built up of erupted material, from which are emitted molten rock or lava, fragmental solid material, hot water and mud, steam, and various gases (La Forge). A volcano is called *active* while it is in eruption, *dormant* during a long cessation of activity, and *extinct* after eruptions have altogether ceased (Webster). *See* Free-flowing volcano; also Explosive volcano.

Volcanology. The science treating of volcanic phenomena. (Webster)

Volgian. A division of the Jurassic rocks of Northern Russia. (Century)

Volhynite. A porphyrite containing plagioclase, hornblende, and biotite phenocrysts in a holocrystalline groundmass of feldspar and chlorite. The name was given by Ossovsky, and it is based on the original occurrence in Volhynia. (Kemp)

Volley. In mining, the act of exploding blasts in sections (Standard). A round of holes fired at any one time.

Volt. The unit of electro-motive force; *i. e.*, a force which steadily applied to a conductor whose resistance is one ohm will produce a current of one ampere. (Webster)

Voltage. Electrical potential, or potential difference expressed in volts, as the voltage of a current. (Webster)

Volta's list. A list or series of metals such that any one will be at a higher electrical potential when put in contact with any of those which follow, and at a lower potential if in contact with any metal before it in the series. The following is such a list: zinc, lead, tin, iron, copper, silver, and gold. (Standard)

Voltear la torta (Sp.). Spading or turning the *torta*. (Egleston)

Voltzite. An oxysulphide of zinc, Zn_4S_4O, occurring in implanted spherical globules of a yellowish or reddish color. (Webster)

Volumetric analysis. The analysis of a compound by determining the quantity of a standard solution required to satisfy a reaction in a known quantity of the compound. (Standard)

Volumetric efficiency. Volumetric efficiency is the ratio of the capacity to the displacement of the air compressor. (A. I. M. E., Bull. 140, p. lvii)

Volumetric grains (Eng.). Grains of a definite size or diameter, but of a variable density which fall through water at different rates of velocity. (Hunt)

Vómito (Colom.). An outcrop. (Halse)

Vooga hole. Same as Vug. (Standard)

Vorhauer (Pr.). An experienced miner, or the "Old man of the stall." He corresponds to the first man or butty collier of English mines. (Gresley)

Vough (Corn.). Same as Vug. (Standard)

Vou-hole; Vooga (Corn.). A natural cavity, hole, or chasm, in the earth or a mine. Called Shack in Derbyshire (Pryce). A vug.

Voua (Scot.). *See* Veal.

Voussoir (Fr.). Any of the tapering or wedge-shaped pieces of which an arch or vault is composed. The middle one is usually specifically called the Keystone. (Webster)

Vuelta. 1. (Mex.). In refining silver, the moment when impurities have been removed (Dwight)
2. The brightening of silver in cupellation (Halse). *See* Blick.

Vug; Vugg; Vugh. A cavity in the rock, usually lined with a crystalline incrustation. *See* Geode (Raymond). Sometimes written Voog; Vough.

Vuggy lode. A lode or vein in which vugs or drusy cavities are of frequent occurrence. (Power)

Vuggy rock (Eng.). A stratum of cellular structure, or one containing many cavities. (Gresley)

Vulcan. 1. The Roman god of the fiery element, especially in his fearful aspects, whose cult, according to tradition, was brought to Rome by the Sabine king Titus Tatius. Later he was identified with the Greek Hephæstus and was hence represented as consort of Venus and god of metal working. (Webster)
2. A volcano. (Century)

Vulcanism. Same as Volcanism.

Vulcanist. In geology, one who holds or taught the Plutonic theory of the formation of rocks. *See* Plutonic. *Compare* Neptunist. Usage obsolete.

Vulcanite. A hard rubber produced by vulcanizing with sulphur. *See* Ebonite. (Webster)

Vulcanize. To treat india-rubber with some form of sulphur to effect certain changes in its properties, and yield a soft or hard product. (Century)

Vulcan oil. A petroleum product having a specific gravity of 0.910 to 0.960 at 15° C. (Bacon)

Vulcan powder. A dynamite composed of nitroglycerin (30 parts), sodium nitrate (52.5), charcoal (10.5), and sulphur (7). Used in mining and blasting. (Webster)

Vulpinite. A scaly, granular variety of anhydrite; it is cut and polished for ornamental purposes. (Dana)

Vulsinite. A variety of latite containing phenocrysts of sanidine, andesine, augite, and biotite in a groundmass of trachytic habit (La Forge). The name is derived from the Vul-

sinii, an ancient Etruscan tribe inhabiting the region where the type specimens were obtained. *Compare* Latite and Trachydolerite. (Kemp)

V-vat. 1. A funnel box; also, having a groove or grooves of a triangular section. (Webster)
2. A spitzkasten. (Standard)

W.

Wacke. Residual sand and clay formed by the decay of diabase, basalt, basaltic tuff, and similar rocks. (La Forge)

Wad. 1. Bog manganese. An impure mixture of manganese and other oxides. It contains 10 to 20 per cent of water, and is generally soft, soiling the hand. A variety known as asbolite carries as much as 32 per cent of cobalt (U. S. Geol. Surv.). Also called Black ocher; Earthy manganese. Lampadite.
2. In ceramics, a piece of clay used for various purposes, as a strip of moist clay laid around the rim of a seggar to form a bed for a superimposed seggar in the kiln. 3. (Eng.) Black lead; graphite. (Webster)

Wad coil (Eng.). A tool for extracting a pebble or broken tool from the bottom of a bore-hole. It consists of two spiral steel blades arranged something like a corkscrew. *See* Spiral worm (Gresley). Also called Wad-hook.

Wad-hook. *See* Wad Coil; *also* Spiral worm.

Waff; Waft (Scot.). To fan out as fire-damp from the working rooms (Barrowman). *See* Brush; *also* Dadding.

Waffle ingot. An ingot of aluminum about 3 inches square and ½ inch thick. (Webster)

Wage. In ceramics, to knead, work, or temper, as clay. (Webster)

Wageman (Leic.). A collier who is paid by the day for performing a fixed amount of work (Gresley). The American equivalent is company man; also time worker as distinguished from pieceworker. A wage earner.

Waging board. In ceramics, a board or table upon which potters' clay is kneaded. (Standard)

Wagnerite. A vitreous, yellow, grayish, flesh-red or greenish, translucent, crystalline fluophosphate of magnesium, $Mg_3P_2O_8.MgF_2$. (Dana)

Wagon. 1. A mine car (Chance). The British spelling is waggon and in Great Britain it is synonymous with Box, Corf, Hutch, Skip, Tram, and Tub. (Gresley)
2. (Scot.) A measure of weight equal to 24 hundredweight. Coal sold for delivery in carts is usually sold by the wagon of 24 hundredweight. (Barrowman)

Wagon breast. A breast in which the mine cars are taken up to the working face. (Chance)

Wagon drill. A reciprocating drill operated by steam or compressed air. It is similar to a tripod drill, but is mounted on a truck and employs long steel which does not require frequent change. (Bowles)

Wagoner (No. Staff.). A man or boy who with a horse hauls mine cars underground. (Gresley)

Wagon hole (Eng.). The place where the tramway ends in a working place.

Wagon mine. Same as Snowbird mine.

Wagon way (No. of Eng.). An underground engine-plane or horse-road.

Wailer (No. of Eng.). A boy who picks out the rock and other rubbish that falls through a screen into the mine car with the coal (Gresley). A variation of Waler.

Waiters-on (Eng.). Men employed at the top of a shaft to run cars on and off the cage (Gresley). *See* Pithead man.

Walchowite. A yellow, resinous, oxygenated, hydrocarbon that occurs in brown coal at Walchow, in Moravia; it has a specific gravity of 1.0 to 1.069, fuses to a yellow oil at 250° C., and forms a dark brown solution in sulphuric acid (Bacon). Also called Retinite.

Wale (Newc.). To clean coal by picking out the refuse by hand. The boys who do this are called Walers, or Wailers.

Waler. *See* Wale; Wailer.

Waling (Eng.). Cleaning coals by picking out refuse. (Bainbridge)

Walker shutter (Aust.). A shutter having a V-shaped cut in it, provided for large ventilation fans of Guibal type, which by cutting off the discharge of air gradually, reduces the vibration. (Power)

Walking. The movement forward or backward of a dredge by first winding up on one side and then the other, swinging the boat from side to side and thereby advancing with a slight offsetting to the side. (Weatherbe)

Walking beam. An oscillating beam or lever for transmitting power, as in a beam engine, one form of an oil derrick. (Webster)

Walking crane. A light crane traveling on an overhead channel iron and a single rail vertically beneath this in the floor. (Webster)

Walking delegate. An official appointed by a trade union to ascertain whether its rules are observed by its members and by their employers, and to represent the unions in dealing with the employers. (Webster)

Walk out (U. S.). A labor strike. (Webster)

Wall. 1. The side of a level or drift. 2. The country rock bounding a vein laterally (Raymond). The side of a lode. The overhanging side is known as the *hanging wall*, and the lower lying one as the *footwall*.
3. The face of a long-wall working or stall, commonly called Coal wall.
4. (No. of Eng.) A rib of solid coal between two bords. (Gresley)

Wall accretions. Material adhering to the inner walls of a blast furnace between the water jackets and the feed door. (Hofman, p. 376)

Wall bars (Eng.). Prop wood usually cut flat to fix against the roof, close up to the working face, where the roof is liable to break along the line of face. (Gresley)

Wall coal (Scot.). Breast coal; the middle division of three in a seam, the other two being termed top coal and ground coal. (Barrowman)

Wall cutting (Scot.). Side cutting or shearing the solid coal in opening working places; trimming the sides of a shaft. (Barrowman)

Wallers. Laborers who build walls to support back filling. (Sanders, p. 89)

Wall face (Scot.). The face of the coal wall; the working face. (Barrowman)

Walling. 1. The brick or stone lining of shafts. 2. (Derb.) Stacking or setting up ironstone, etc., in heaps, preparatory to being measured or weighed. (Gresley)

Walling crib (Eng.). Oak cribs or curbs upon which shaft walls are built. (Gresley)

Walling stage. A movable wooden scaffold suspended from a crab on the surface, upon which the workmen stand when walling or lining a shaft. (C. and M. M. P.)

Wallow (Mid.). A windlass; a stowse. (Gresley)

Wall plates. 1. (Corn.) The two side-pieces of a timber frame in a shaft, parallel to the strike of the lode when the shaft is sunk on the lode (Raymond). When not sunk on the lode, the two longest horizontal pieces of timber in a set used in a rectangular shaft.
2. (Scot.) Vertical pieces of wood supporting the ends of the buntons in a wood-lined shaft. (Barrowman)

Wall rock. The rock forming the walls of a vein or lode; the country rock. (Century)

Wall saltpeter. Calcium nitrate; so called because it disintegrates mortar. (Webster)

Wallsend (Eng.). A superior coal for household purposes: originally from Wallsend, on the Tyne, but now from any part of a large district in and near Newcastle. (Standard)

Walls of a vein. *See* Wall, 1; *also* Wall rock.

Wall white. A white scum that appears on bricks after they are set in the wall. (Ries)

Wandering coal (Scot.). A coal seam that exists only over a small area; an irregular seam of coal. (Barrowman)

Want. 1. (Scot.) A clean rent or fissure in strata unaccompanied by dislocation. (Gresley)
2. (Eng.) A portion of a coal seam in which the coal has been washed away and its place filled with clay or sand; a nip (Standard). *Compare* Pinch, 2 and 3.

Wapping (Leic.). A roughly-made rope or band of hemp or spun yarn. (Gresley)

Warden (Aust.). The overseer of workers on a gold field. (Standard)

Wargeare (Derb.). A general term for all tools, ropes, timber, and other appliances necessary to carry on the work of a mine. (Hooson)

Wargues (Fr.). A horse-gin. (Gresley)

Wark batch (Som.). A spoil bank. (Gresley)

Warner (Eng.). An apparatus consisting of a variety of delicately constructed machines actuated by chemical, physical, electrical, and mechanical appliances, for indicating the presence of small quantities of fire damp, heat, etc., in mines. (Gresley, 1883)

Warning. 1. (Scot.) Notice, given or received, of a workman leaving his employment. (Barrowman)
2. To put on guard; to give notice, information, or intimation, beforehand of approaching or probable danger (Webster). As to warn workmen of the dangers usually encountered in a mine.

Warning lamp (Eng.). A safety lamp fitted with certain delicate apparatus for indicating very small proportions of fire damp in the atmosphere of a mine. (Gresley, 1883)

Warning signals. Signals given to men in a mine to notify them that some danger exists as fire, etc., by blinking lights, sounding gongs or bells, or by shutting off the compressed air lines.

Warp. 1. (York.) Blue-brown, finely laminated, tough clay, containing pebbles. (Gresley)
2. The deposit of muddy waters artificially introduced into low lands. (Comstock)

Warped (Scot.). Irregularly bedded, or plicated. (Barrowman)

Warrant (Lanc.). Synonymous with Clunch; Pounson, etc. (Gresley). *Compare* Warren.

Warren; Warren earth (Lanc.). Bind; Clunch; etc. (Gresley). *Compare* Warrant.

Warwickshire method. A method of mining contiguous seams. *See* Bord-and-pillar method.

Wash. 1. A Western miner's term for any loose, surface deposits of sand, gravel, bowlders, etc. (Kemp)
2. Auriferous gravel. 3. Coarse alluvium; an alluvial cone. 4. The dry bed of an intermittent stream, sometimes at the bottom of a cañon, as the Amargosa *wash*. Also called Dry wash. 5. To subject, as earth, gravel, or crushed ore, to the action of water to separate the valuable material from the worthless or less valuable; as to wash gold. 6. To cover with a thin coat of metal, as steel washed with silver. 7. To dephosphorize molten pig iron by adding substances containing iron or manganese oxide. 8. To pass a gas through or over a liquid for the purpose of purifying it. (Webster)
9. In founding, to coat, as a core or mold, with an emulsion, as of graphite, in order to improve the casting. (Standard)

Wash bottle. *See* Washing bottle.

Wash dirt. Gold-bearing earth worth washing (Roy. Com.). Also called Wash stuff; Washing stuff; Wash gravel.

Washer. 1. A machine for washing coal or ore, as a log washer, rocker, jig. 2. An apparatus in which gases are washed; a scrubber. (Webster)

Washery. A place at which ore or coal is freed from its impurities by washing (Webster). *See also* Washing apparatus.

Wash fault (Eng.). A portion of a seam of coal replaced by shale or sandstone (Gresley). *Compare* Want, 2.

Wash gravel. Gravel washed to extract gold (Webster). *Compare* Wash dirt.

Wash hole (Eng.). A place for refuse. (Bainbridge)

Wash house. A building on the surface at a mine where the men can wash before going to their homes. A change house. A dry house.

Washing. 1. Gold dust procured by washing; also a place where this is done; a washery. 2. In ceramics, the covering of a piece with an infusible powder which prevents it from sticking to its supports while receiving the glaze. (Webster)
3. In metallurgy, that which is retained after being washed; as, a *washing* of ore. 4. A thin coating of metal. (Standard)

Washing apparatus; Washery. 1. Machinery and appliances erected on the surface at a colliery, generally in connection with coke ovens, for extracting, by washing with water, the impurities mixed with the coal dust or small slack. 2. Machinery for removing impurities from small sizes of coal, or ore. (C. and M. M. P.)

Washing bottle. 1. A bottle or flask fitted with glass tubes passing through the cork, so that on blowing into one of the tubes a stream of water issuing from the other may be directed upon anything to be washed or rinsed. 2. A bottle for use in washing gases by passing them through liquid contained in it. (Webster)

Washing hutch. *See* Hutch, 2.

Washing machine (Scot.). A machine for separating impurities from small coal by means of water. (Barrowman)

Washing-off; Washing-up (U. S. and Aust.). The periodical final cleaning out of all the gutters and appliances used in alluvial and lode gold mining (Davies). Synonymous with Clean-up.

Washing stuff. Any earthy deposit containing gold enough to pay for washing it. *See* Wash dirt. (Webster)

Washing trommel. *See* Trommel.

Washita. A rather coarse-grained novaculite, especially suitable for sharpening carpenters' or general woodworkers' tools. (Pike)

Washoe canary. A miner's slang term for a donkey (Standard). A burro.

Washoe process. The process of treating silver ores by grinding in pans or tubs with the addition of mercury, and sometimes of chemicals such as blue vitriol and salt (Webster). Named from the Washoe district, Nevada, where it was first used.

Wash-out (Aust.). The erosion of part of a seam by aqueous action (Power). *See* Want, 2.

Wash pan. A pan for washing pay gravel in placer-mining. (Standard)

Wash place. A place where the ores are washed and separated from the waste; usually applied to places where the hand jigs are used. (C. and M. M. P.) *See* Washery.

Wash pot. In tin-plate manufacturing, a pot containing melted tin into which the plates are dipped to be coated. (Webster)

Wash stuff. *See* Wash, 2, and Washing stuff.

Wash water. *See* Water wash.

Wasite. In mineralogy, an altered variety of allanite. (Standard)

Waste. 1. That which has no real value, as barren rock in a mine, or the refuse from ore dressing and smelting plants. Gob; goaf; old workings; also the fine coal made in mining and preparing coal for market; culm; coal dirt; also used to signify both the mine waste (or coal left in the mine in pillars, etc.) and the breaker waste.
2. (Eng.) A more or less empty space between two packs. *See* Goaf.
3. (No. of Eng.) A return airway. (Gresley)
4. Material derived by mechanical and chemical erosion from the land, carried by streams to the sea. 5. In stone cutting, to reduce roughly to a flat surface by chipping. (Webster)
6. Broken or spoiled castings for remelting. (Standard)

Waste coal (Eng.). Coal obtained as a by-product from mine waste. (Gresley)

Wasteman (Mid.). One who looks after and keeps clean the airways of a mine, and keeps the clay walls (brattices) in proper condition. (Gresley).

Waster. 1. A spoiled, imperfect, or rejected casting, molding, piece of pottery, etc. 2. Tin plate below the standard weight and quality. (Standard)

Waste room (Scot.). An abandoned working place. (Barrowman)

Waster waste. The lowest grade of waste tin-plate. (Standard)

Wastes (Derb.). Vacant places left in the gobbing, on each side of which the rubbish is packed up for the better support of the roof. (Min. Jour.)

Waste water. Water from old mine workings (Barrowman). Also water from any metallurgical process, or the overflow from a storage reservoir.

Wasteway. A conduit for waste water. (Webster)

Wasteweir. *See* Weir, 2.

Wastings (Scot.). Mine workings. (Barrowman)

Wastrel (Eng.). A tract of waste land; or any waste material. (Raymond)

Watch. In ceramics, a trial piece of clay placed in the kiln, to be withdrawn and examined from time to time, as an index of the condition of the ware being fired. (Webster)

Watchers (Leic.). Experienced colliers who go into the mine and examine the whole of the workings, with a deputy, every Sunday. (Gresley)

Water. The transparency or luster of a precious stone or pearl; hence, the aggregate of qualities that make it valuable (Standard); as a diamond of the first water.

Water balance. 1. (Scot.) An arrangement by which a descending tank of water raises mineral in a shaft by a rope passed over a pulley. Sometimes used where water is abundant and can be run off at the pit bottom by means of an adit. (Barrowman)
2. An obsolete water-raising apparatus consisting of a swinging frame carrying a double series of troughs ascending in zigzag lines, and so adjusted to each other that, as the frame rocks in either direction, water may be passed to a higher level. (Standard)

Water baler (Aust.). A man who bales water out of dip workings in places where it is not convenient to put in a pump. (Power)

Water barrel; Water tank. A barrel or box, with a self-acting valve at the bottom, used for hoisting water in lieu of a pump. (Raymond)

Water bed. A bed of coarse gravel or pebbles occurring in the lower part of the upper till in the Upper Mississippi valley. (Standard)

Water blast. 1. (Eng.) The sudden escape of air pent up in rise workings under considerable pressure from a head of water that has accumulated in a connecting shaft. (C. and M. M. P.)
2. (Scot.) The discharge of water down a shaft to produce or quicken ventilation (Barrowman). *See also* Trombe.

Water block. A hollow box or block of iron, through which water is circulated, to protect part of a furnace wall. (Webster)

Water boss (Aust.). The owner or holder of water or water rights, who sells the same for mining purposes. (Davies)

Water box. 1. A square, open, wooden tank-car used for removing small amounts of water from low places in a mine. Also the tank-car used for sprinkling the roadways to settle the dust. (Steel)
2. A water-case attached to the outside of a furnace, to protect the iron from the effects of fire. (Standard) Also called Water block.

Water cartridge. A waterproof cartridge surrounded by an outer case. The space between being filled with water, which is employed to destroy the flame produced when the shot is fired, thereby lessens the chance of an explosion should gas be present in the place. (Steel)

Water cement. Same as Hydraulic cement. (Standard)

Water core. A hollow core through which water circulates in a mold used for cooling the interior of a casting more rapidly than the outside while the metal is solidifying, as in casting a cannon. (Webster)

Water course. A natural or artificial channel for passage of water as a river, canal, flume, or drainage tunnel.

Water curb (Eng.). *See* Garland.

Watered (Eng.). Containing much water—full of springs or feeders: *e. g.* heavily watered mines, heavily watered measures, etc. (Gresley)

Water engine (Scot.). An engine used exclusively for pumping water. (Barrowman)

Water flush. A system of well boring, in which percussive drills are used in connection with water forced down to the bottom of the hole through the drill rods. This water jet makes the tools cut better, and washes the detritus up out of the hole. (Nat. Tube Co.)

Water gap. A pass in a mountain ridge through which a stream runs. (Webster)

Water gas. A gas made by forcing steam over incandescent carbon (coke) whereby there results a mixture of hydrogen and carbon monoxide. It is sometimes used as a fuel, but usually is carburetted with illuminating constituents prepared from oil and used as illuminating gas. (Webster)

Water-gas tars. Tars produced by cracking oil vapors in the manufacture of carbureted water gas. (Bacon)

Water gage. 1. An instrument to measure the ventilating pressure; the term is also used to denote the ventilating pressure in inches. (Chance)

2. An instrument to measure or find the depth or quantity of water, or to indicate the height of its surface, as in a steam boiler. (Webster)

Water gin (Scot.). A gin actuated by a water wheel. (Barrowman)

Water glass. 1. A glassy or stony substance consisting of silicates of sodium or potassium, or both, soluble in water forming a viscous liquid. 2. A water gage for a steam boiler. (Webster)

Water grade. 1. The inclination of an entry that is just sufficient to drain off the water. 2. A grade determined by keeping the working place nearly parallel to the edge of the pool of water standing upon its floor. Water grade is sometimes incorrectly called Water level. (Steel)

Water hammer. 1. The hammering noise caused by the intermittent escape of gas through water in mines. (Gresley)
2. The concussion of moving water against the sides of a pipe on a sudden stoppage of flow, as made by water in a steam pipe. (Webster)

Water inch. The discharge from a circular orifice 1 inch in diameter with a head of one line (one-twelfth inch) above the top edge commonly estimated at fourteen pints per minute; an old unit of hydraulic measure. (Webster)

Water jackets. Cast- or wrought-iron sections of a furnace so constructed as to allow free circulation of water for keeping the furnace cool. Also called Water block; Water box.

Water kibble. A large iron bucket with a valve in the bottom for self-filling: sometimes used in hoisting the water from a mine. (Standard) *See also* Water barrel.

Water leaf (Scot.). *See* Top ply.

Water level. 1. The level at which, by natural or artificial drainage, water is removed from a mine or mineral deposit. 2. A drift at the water level (Raymond). *See* Water grade.

Water Leyner. A type of rock drill in which water is fed into the drill hole through the hollow drill steel, to remove the drill cuttings, and at the same time allay the dust. Also known as Leyner-Ingersoll drill.

Water lime. 1. Hydraulic lime. 2. A Silurian limestone formation overlying the Salina proper of New York. Hydraulic lime is made from it. (Webster)

Water load (So. Wales). The head, or pressure per square inch, of a column of water in pumps, etc. (Gresley)

Water lodge (Eng.). A lodge; a sump. (Gresley)

Water machine (Scot.). A pump or other appliance actuated by a water wheel for raising water. (Barrowman)

Watermen (Corn.). Men employed about water underground; especially those who drew water at the rag-and-chain pump. (Pryce)

Water of crystallization. The water that combines with salts when they crystallize. It is a definite quantity, and may be accepted as a molecular constituent of the crystalline compound (Standard). It is yielded by the crystals containing it upon heating.

Water of imbibition. 1. The proportionate amount of water that a rock can contain above the line of water level or saturation. Called also Quarry water. 2. Water of saturation. (Standard)

Water opal. Same as Hyalite. (Standard)

Water packer. A device to cut off water from the lower levels of an oil well, or to separate two distinct flows of oil from different strata. (Nat. Tube Co.)

Water parting. The boundary between two river basins; a watershed. (Century)

Water plane. In geology, the upper surface of a bed of water, as of ground-water. (Standard)

Water pocket (local, U. S.). A bowl, in rock structure, that has been formed by the action of falling water. (Standard)

Water power. 1. The power of water derived from its gravity or its momentum as applied or applicable to the driving of machinery. 2. A descent or fall in a stream from which motive power may be obtained; especially, in law, the fall in a stream in its natural state, as it passes through a person's land or along the boundaries of it. (Standard)

Water privilege. 1. The right to the use of the water of a certain stream. 2. The right to the possession and use of a fall of water for mechanical purposes. (Standard). (U. S. Min. Stat., pp. 609–612)

Water-quenched. Cooled with water, as steel in tempering. (Standard)

Water right. The right to use water for mining, agricultural, or other purposes. (U. S. Min. Stat., pp. 609–612; 615; 946). *See also* Water privilege.

Water ring (Aust.). A trough cut into the wall of a shaft in which water collects, and is led down pipes to a pumping station. (Power)

Water-rolled. In geology, more or less rounded and smoothed by the mechanical action of moving water, in the waves on a beach, or in the current of a stream. (Standard)

Water sapphire. *See* Cordierite, 1.

Water seal. A seal formed by water to prevent the passage of gas. (Webster)

Watershed. The height-of-land or divide from which the natural drainage of a district flows in opposite directions. (Roy. Com.)

Water sink. A pot hole. (Standard)

Water slip. A fault or joint from which water flows. (Steel)

Water smoke. To fire (a kiln) slowly in order to dry out the moisture from the bricks, before burning. (Standard)

Water-soluble oils. Oils having the property of forming permanent emulsions or almost clear solutions with water. (Bacon)

Water stone. A stone whose cutting crystals break away rapidly from its bond. The use of water forms a gritty paste which acts in much the same way as oil when used on an oilstone. The Queer Creek and Hindostan stones are good examples of water stone. (Pike)

Water struck. In brickmaking, made in a mold without pressure: said of slop bricks. (Standard)

Water surface. In oil wells, the level or inclined plane between the oil, or gas, and the edge water upon which the oil or gas rests. Not to be confused with ground-water level or table. (U. S. Geol. Surv. Bull. 258, p. 48)

Water table. 1. (Aust.) An elevated drain placed across a tram track to carry off surface water. 2. The upper limit of the portion of the ground wholly saturated with water. This may be very near the surface or many feet below it. (Webster)

Water tender. A boiler-house employee attending to feed water of boilers, and usually also to blow-off valves. (Willcox)

Water tower. 1. A stand-pipe or its equivalent giving a head to a system of water distribution. 2. A tower in which a falling spray of water is used to wash gas, etc. (Standard)

Water tuyère. A water jacketed tuyère. (Webster)

Water vein. Any one of the small underground streams of water often flowing through beds otherwise barren of water. (Standard)

Water wash. The use of water to remove the soluble constituents of a mill product before further treatment. (Clennell, p. 219)

Water way (Scot.). The area in a clack or bucket for the passage of water. (Barrowman)

Water wheel. A wheel so arranged with floats, buckets, etc., that it may be turned by flowing water: used to drive machinery, raise water, etc. The *overshot* and *undershot* water-wheel, the *breast-wheel*, and *tub-wheel* are now largely discarded in favor of the *turbine*. (Standard)

Water yardage (Ark.). Extra payment to miners who work in a wet place, either by the yard of progress or the ton of coal mined. (Steel)

Watt. An electrical unit of power or activity equal to work done at the rate of one joule a second or at the rate of work represented by a current of one ampere under a pressure of one volt. A volt-ampere. A horsepower is equal to 746 watts. (Webster)

Waugh drill. *See* Rock drill.

Wavellite. Hydrous aluminum phosphate, $Al_6(OH)_6(PO_4)_4+9H_2O$. Fluorine is present in some specimens up to 2 per cent. (U. S. Geol. Surv.)

Wavy extinction. Irregular extinction of a mineral under the microscope due to bending or distortion of the crystal. (Luquer, p. 16)

Wavy vein. A vein that alternately enlarges or pinches at short intervals. (Power)

Wax. 1. An unctuous, fusible, and more or less viscous to solid substance, having a characteristic "waxy" luster, and insoluble in water, but more or less soluble in carbon disulphide, benzol, etc. Waxes are extremely susceptible to changes in temperature. (Bacon) 2. (Leic.) Soft or puddled clay used for dams or stoppings, in the mine. (Gresley)

Wax coal. *See* Earthy brown coal.

Wax dam (Leic.). A wall or dam of clay (Gresley). Called also a Wax wall.

Waxing (Leic.). The operation of plastering a waste stack with clay. *See* Stack out. (Gresley)

Wax distillate. Neutral oil distillate before the separation of paraffin wax. (Bacon)

Wax opal. An early name for yellow opal with a waxy luster. (Chester)

Wax tailings. A residual product, containing chrysene, picene, and other compounds, formed by destructive distillation of petroleum. It is of dark-green color but darkens on exposure to light; is asphaltic in nature and varies in melting point according to the care with which it is separated and later refined. It is used for weather and waterproofing compounds, in some cases as a flux in street paving mixtures, and as a filler in very cheap axle grease. (Bacon)

Wax wall (Leic.). A clay wall about ten inches in thickness built up from floor to roof, alongside a gob road a few feet within the goaf, to keep back or prevent fire-stinks, etc. (Gresley). *Compare* Wax dam.

Way. 1. (No. of Eng.) Any underground passage or heading driven more or less on the level of the coal, along which the produce of the mine is conveyed. A gate, road, or wagonway. 2. The rails, sleepers, etc., upon which cars, tubs, or corves run. (Gresley)

Wayboard (Eng.). A thin layer or band that separates or defines the boundaries of thicker strata; as thick beds of limestone separated by "wayboards" of slaty shale; of sandstone separated by "wayboards" of clay (Page). Also written Weighboard.

Way dirt (Leic.). The slack, dust, and lumps of coal which fall from the cars upon the roads from the working places to the shafts. It is collected during the night and sent to the bank and used under the boilers. (Gresley)

Way end (Scot.). The inner extremity of the wooden railways formerly used in mines (Barrowman). The end of an entry or roadway.

Waygate. The tail-race of a mill. (Century)

Way head (Mid.). The end of a way or gate next to the face. (Gresley)

Way leave (Eng.). 1. A rent or royalty paid by the owner or lessee of a mine for conveying minerals belonging to one person through the property of another person. 2. (No. of Eng.) The right of making and maintaining colliery railways through private property which may intervene between collieries and coal docks (Gresley). *See* Easement.

Way shaft. A winze. (Standard)

Weak veins (No. of Eng.). Veins so called when the strata on either side are but slightly displaced. (Power)

Weald clay (Eng.). Thick blue clays, having in the upper part septaria of argillaceous ironstone, and in the lower part beds of the shelly freshwater limestone known as "Sussex, Petworth, or Bethersden marble." (Page)

Wealden. In geology, a thick fluviatile delta of the Lower Cretaceous in England. (Standard)

Weather. To undergo or endure the action of the atmosphere; to suffer meteorological influences; sometimes, to wear away (Webster). In geology, specifically, to discolor, crumble, or otherwise change by means of atmospheric action. Said of rocks.

Weather door. A door in a mine level to regulate the ventilating current (Raymond). A trap door.

Weathering. The group of processes, such as the chemical action of air and rain water and of plants and bacteria and the mechanical action of changes of temperature, whereby rocks on exposure to the weather change in character, decay, and finally crumble into soil. (Ransome)

Weather stain. Discoloration from exposure to the atmosphere (Standard.) Said of rocks and minerals.

Web (Mid.). The face or wall of a long-wall stall in course of being holed and broken down for removal. (Gresley)

Websterite. 1. A name proposed by G. H. Williams for the pyroxenites near Webster, N. C., that consist of diopside and bronzite, with the latter porphyritically developed. The name Websterite had been previously used by A. Brogniart in 1822 for aluminite. (Kemp)
2. Aluminite. (Dana)

Wedding (Derb.). The accidental meeting or collision between a loaded and an empty bucket in a mine-shaft when hoisting with a swinging rope, without guides. (Gresley)

Wedge. In ceramics, to cut as clay, into wedgelike masses and work by dashing together, as to expel air bubbles. (Webster)

Wedge ring (Eng.). A wedging crib. (Gresley)

Wedge rock. An expression used on the Comstock lode to designate rock too poor to be classed as "pay ore" or even "second-class ore," but better than waste. It usually assays under $5 per ton. When a car is placed on the cage to be hoisted, it is specially tagged in the case of good ore. If it be waste no tag is used; it became the custom to throw a wooden wedge on top of the car of very low-grade ore, hence the term "wedge-rock." (Eng. and Min. Jour., vol. 93, p. 391)

Wedging. The material, moss or wood, used to render the shaft-lining tight. (Ihlseng)

Wedging-curb; Wedging-crib (Eng.). A curb used to make a water-tight packing between the tubbing in a shaft and the rockwalls, by means of split deals, moss, and wedges, driven in between the curb and the rock. (Raymond)

Wedging down. Breaking down the coal at the face with hammers and wedges instead of by blasting. (Gresley)

Wedging out (Eng.). Cropping out, or thinning out (Gresley). Said of coal beds.

Wedging shot. An opening shot (Steel). A center-cut.

Wedgewood ware. In ceramics, a fine hard porcelainlike ware first produced by Josiah Wedgwood (1780–95) of England. It consists of a tinted clay ground, with small cameo reliefs in white paste, applied before firing (Webster). The principal varieties are: (a) *bamboo ware*, yellowware named from its color; (b) *basalt ware*, ware with a black body, used for relief placques, medallion portraits, vases, etc.; (c) *cameo-ware* (which *see*); (d) *jasper-ware* (which *see*); (e) *pebble ware*, ware with a variegated body of different colored clays intermingled, called, according to pattern, *agate*, *Egyptian pebble*, *granite*, *lapis-lazuli*, *porphyry*, *serpentine*, *verd-antique*, etc.; (f) *queen's ware* (which *see*). (Standard)

Weeldrons (Forest of Dean). Ancient ironstone workings (Gresley). Also Weeldon. Probably a variation of *Wealden*, the lowest division of the Lower Cretaceous in England.

Weeper; Weep hole. A hole in a retaining wall to permit the escape of water from behind (Standard).

Weeping rock. A porous rock from which water oozes. (Century)

Weese (Scot.). An iron joint-ring covered with flannel, and tarred or tallowed, for insertion between pump pipes. (Barrowman) *Also* Welze.

Wehrlite. 1. A variety of peridotite composed essentially of olivine and monoclinic pyroxene. (La Forge)
2. A foliated bismuth telluride of doubtful formula, containing about 30 per cent tellurium, and often some silver. (Dana)

Weigh (So. Wales). A weight of 10 tons of coal, etc. (Gresley)

Weigh basket; Weigh pan. Any receptacle in which the coal is weighed after it is dumped from the mine cars. (Steel)

Weigh board (Eng.). Clay intersecting or separating a vein (Bainbridge). *See* Wayboard.

Weigh bridge (Eng.). A platform large enough to carry a wagon, resting on a series of levers, by means of which heavy bodies are weighed. (C. and M. M. P.)

Weighing (Eng.). The crushing or falling in of the roof, more or less rapidly (Gresley). *Compare* Weight, 1.

Weigh pan. *See* Weigh basket.

Weight. 1. (Scot.) The pressure of the upper strata on the coal face, by which, if the working is systematically carried on, the excavating of the mineral is facilitated. (Barrowman)
2. (Eng.) The number of hundredweights (cwts.) which are reckoned as one ton as between coalmasters and workmen (hewers, trammers, banksmen, etc.). (Gresley)
3. (Aust.) A pennyweight. 4. The quality of being heavy; a measure of the force of gravity. (Webster)
5. In founding, to place weights upon (the upper box of a flask), to prevent the parts from separating by pressure of molten metal. (Standard)

Weighting (Eng.). Undergoing disturbance due to weight. Commonly known as being "on the weight" or "taking weight" (Gresley). Said of the roof of a mine.

Weir. 1. An obstruction placed across a stream for the purpose of diverting the water so as to make it flow through a desired channel, which may be a notch or opening in the weir itself. The term usually applies to rectangular notches in which the water touches only the bottom and ends, the opening being a notch without any upper edge. (C. and M. M. P., p. 138). A dam.
2. That part of a dam, embankment, canal bank, etc., which contains gates and over which surplus water flows: specifically called Waterweir. (Standard)

Weir table. A record or memorandum used to estimate the quantity of water that will flow in a given time over a weir of a given width at different heights of the water. (Century)

Weiselbergite. Rosenbusch's name for those augite-porphyrites whose groundmass consists of a second and sometimes a third generation of plagioclase rods and augites, arranged in flow lines in a glassy basis. Wadsworth uses the name for an altered andesite glass. (Kemp)

Weize (Scot.). A band or ring of spun yarn, rope, gutta-percha, lead, etc., put in between the flanges of pipes before bolting them together, in order to make a water-tight joint (Gresley). Packing. *See also* Weese.

Weld. 1. To join pieces of metal by pressure, at a temperature below that of complete fusion. (Raymond)
2. The consolidation of pieces of metal by welding; also, the closed joint or welded seam so formed. (Standard)

Welder. 1. One who or that which welds. 2. A step-down transformer specially constructed for electric welding. (Webster)

Welding-heat. The temperature necessary in order that two pieces of material may be welded together; especially the white heat at which bars of iron unite in a weld. (Standard)

Welding powder. A flux used in welding, usually consisting of borax, ammonium chloride, iron-filings, and sometimes of a resinous oil: mixed in different proportions. (Standard)

Welding-swage. A swaging-tool used to aid in closing the seam of a weld. (Standard)

Welding-transformer. A step-down transformer used in welding (Standard). *See* Welder, 2.

Weld-iron. Wrought-iron (Raymond). A term suggested by an international committee of the American Institute of Mining Engineers.

Weldon mud. *See* Weldon process.

Weldon process. A process for the recovery or regeneration of manganese dioxide in making chlorine, by means of milk of lime and the oxygen of the air. The regenerated product (Weldon mud) is a slime containing compounds of calcium and manganese, and yields chlorine when treated with hydrochloric acid. (Webster)

Weld-steel. Puddled steel: a term suggested by an international committee of the American Institute of Mining Engineers. (Standard)

Well. 1. The crucible of a furnace. (Raymond)
2. A shaft or hole sunk into the earth to obtain oil, gas, water, etc.
3. A hollow cylinder of masonry sunk to form a foundation. (Webster)
4. A cavity in the lower part of some sorts of furnaces to receive falling metal (Standard). 5. *See* Trap, 5.

Well-boring jar. *See* Jars.

Well drill. Same as Churn drill. (Bowles)

Well-drill holes. Holes drilled by means of an apparatus known as the well drill, or similar to that, and used for blasting on comparatively large scale. Such holes are usually 5 or 6 inches in diameter and from 30 to 150 feet deep. (Du Pont)

Well hole (Aust.). The sump, or portion of a shaft below the place where skips are caged at the bottom of the shaft, in which water collects. (Power)

Wellman producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 323)

Well packing. A bag of flaxseed or other absorbent material packed around the tube of an oil well to prevent access of water to the oil in the well. (Standard)

Well rig. An assemblage of all mechanisms, including power-motors, necessary to drilling, casing, and finishing a tube or drilled well. (Standard)

Well shooting. The firing of a charge of nitroglycerin, or other high explosive, in the bottom of a well for the purpose of increasing the flow of water, oil, or gas. (Du Pont)

Well sinker. One who sinks or digs wells (Century). Also called Well borer.

Wells of Stromboli. Cavities at the summit of the volcano Stromboli, containing water, probably condensed from vapor from the interior. (Standard)

Well tube. A tube or tubing used to line wells. (Standard)

Well-tube filter. A strainer on a driven well tube to keep out grit. (Standard)

Well-tube point. A point at the end of a perforated tube used for sinking wells. (Standard)

Welsh bord (Aust.). A room in which mine waste is stored in the middle, and a roadway is kept open on either side. (Power)

Welsh lay. A slate 3 feet long by 2 feet wide. (Standard)

Welshman. A heavy steel ring about three or four inches inside diameter, used in withdrawing a bar which is stuck or frozen in a skull of iron. The ring is placed on the bar, a wedge inserted, and the bar backed out by sledging on the wedge. (Willcox)

Welsh process. A process consisting of a succession of roasting and calcining copper ore, thereby obtaining a gradual concentration of copper by the oxidation of most of the foreign matter, part of which forms slag. Blister copper is produced with only a small percentage of impurities (Goesel). Also called English process.

Wenlock formation (Eng.). A characteristic group of limestone, slate, and shale of the Upper Silurian strata, typically developed near Wenlock, in Shropshire. (Page)

Wenlock group. *See* Wenlock formation.

Wernerian. Of or pertaining to A. G. Werner (1750–1817), a German mineralogist and geologist who classified minerals according to their external characters, and advocated the theory that the strata of the earth's crust were formed by depositions from water; neptunian. (Webster)

Wernerite. Common scapolite. A mineral of the scapolite group, intermediate in composition between meionite and marialite. (Dana)

Westfalite. A blasting explosive composed of ammonium nitrate and resin. (Webster)

Westphal balance. A form of balance used in determining the specific gravity of liquids, mineral, fragments, etc. (Webster)

Westrumite. A "soluble oil" patented by Westrum in 1903, for the sprinkling of roads with the object of "laying" dust. It is an emulsion of oil in a large quantity of water. (Bacon)

Wet-bulb thermometer. That one of two similar thermometers of a psychrometer, the bulb of which is moistened (Webster). *See* Psychrometer.

Wet gas. Natural gas that contains more or less oil vapors. It occurs with or immediately above the oil. Also sometimes called Casing-head gas.

Wetherill's furnace. A furnace with perforated iron bottom, under which a blast is introduced, and upon which zinc ore (red oxide) is reduced (Raymond). A muffle furnace for roasting zinc ores. (Ingalls, p. 159)

Wetherill's magnetic separator. An apparatus for separating magnetic minerals from nonmagnetic minerals. It consists of two flat belts, the upper of which is the wider, run parallel to each other, and over long magnets set obliquely to the belts. Consequently magnetic particles are drawn up against the upper belt, and as they pass beyond the influence of the magnets, fall from the edge past the other belt into a bin. Another form operates by belts moving across the line of travel of the main belt. (Liddell)

Wethey furnace. A multiple-deck, horizontal furnace for calcining sulphide ores. Resembles the Keller furnace. (Hofman, p. 195; Ingalls, p. 111)

Wet method. 1. In the manufacture of Portland cement, mixing of raw materials in a wet condition. This method is usually employed where marl is used, the marl being usually wet when excavated and is kept wet during the entire process until it reaches the kilns. (Bowles)
2. Any hydro-metallurgical process, as the cyanide process, flotation, etc. *See* Wet process.

Wet milling-plant. A mill in which a wet process is employed. (Rickard)

Wet milling plant. A mill in which water is wasted; it is a sloppy establishment. (Rickard)

Wet natural-gas. Natural gas which contains readily condensible gasoline, that may be extracted in quantity sufficient to warrant the installation of a plant. (B:..n)

Wet pan. A machine used in the preparation of clay products and consisting of a revolving pan with two large mullers, underneath which the charge of wet clay has to pass. (Watson, p. 521)

Wet place (Aust.). A place is considered wet if men have to work constantly in 3 inches of water or more, or when water is constantly dripping on them from the roof. (Power)

Wet process. A metallurgical process in which the valuable contents of the ore are dissolved by acid or other solvents; a leaching or lixiviation process. Opposed to Dry process.

Wet puddling. The ordinary process of puddling in which the furnace is lined with material rich in oxide of iron. (Standard)

Wet rods (Scot.). Pump rods inside the pipes in a bucket lift. (Barrowman)

Wetterdynamite. Originally, only guhr dynamites to which were added salts containing water of crystallization, as Glauber's salts, ammonium oxalate, etc., with the view of making them available in mines containing fire damp. (Brunswig, p. 307)

Wetter-off. In glassmaking, a worker who detaches the blown glass from the pipe by touching it with a wet tool. (Webster)

Wey; Weigh (Eng.). A certain weight of coal usually 10 tons, upon which a royalty is paid. (Gresley)

Wharl; Wharr (Newc.). A sledge for hauling corves in low drifts. (Raymond)

Whave (Prov. Eng.). To turn while drying, as pottery. (Standard)

Wheal. The Cornish name for a mine. (Skinner)

Wheel (Corn.). An abbreviation of water wheel, implying a water engine. (Pryce)

Wheel base. The distance between the points of contact of the front and back wheels of any vehicle with the rails, or other surface, upon which they travel. (Century)

Wheel brae. 1. (Scot.) A self-acting incline; a cousie. (Barrowman)
2. A flat or landing on the top of an incline. (Gresley)

Wheeler (Aust.). A lad who drives horses drawing skips to and from working places, and the nearest collecting station. (Power)

Wheelerite. A yellowish resin, found in the Cretaceous beds of northern New Mexico, filling the fissures of the lignite, or interstratified in thin layers. It is soluble in ether. (Bacon)

Wheel house (Brist.). A shed for protecting the horse gin or other hoisting apparatus. (Gresley)

Wheelman (Scot.). The man who attends to the wheel or drum at an incline. (Barrowman)

Wheel ore. Same as Bournonite. So-called when occurring in wheel-shaped twin crystals. (Webster)

Wheel pit. A pit in which the lower part of a fly wheel runs. (Webster)

Wheel race. The place in which a water wheel is set. (Webster)

Wheel scraper. A scraper mounted upon an axle supported by a pair of wheels. It affords an easy means of conveying a loaded scraper to a dumping ground. (Bowles)

Wheeltree (Scot.). A prop to which the pulley on a short self-acting incline is fastened. (Barrowman)

Whewellite. Calcium oxalate, $CaC_2O_4 + H_2O$. In small colorless monoclinic crystals. From Saxony, with coal. (Dana)

Whim. A large capstan or vertical drum turned by horse power or steam power, for raising coal, or water, etc., from a mine (Hargis). Called also Whimsey; Whim gin; Horse gin.

Whim driver (Corn.). One who attends to the horse at the whim. (Min. Jour.)

Whim gin. *See* Whim.

Whim kibbal (Corn.). A bucket or small tub used in connection with a whim for hoisting ore, rock, or water. (Pryce)

Whim rope; Whim chain (Corn.). The rope or chain by which the kibble is attached to the winding engine or whim. (Min. Jour.)

Whimsey (Eng.). An old word for the hoisting apparatus at a mine, now known as the winding engine; a whim. (Gresley)

Whim shaft (Corn.). The shaft through which the ore is raised by means of a whim. (Whitney)

Whin. 1. Whinstone or whinrock. In Nova Scotia the miners apply this term to a thick-bedded rock composed of grains of quartz with argillaceous or feldspathic matter which might be called a greywacke. (Roy. Com.)
2. (Scot., No. of Eng.) Any very hard resisting rock encountered by miners (Gresley). The Scotch name for greenstone.
3. A whim or winch. (Webster)

Whin dike (Scot.). A dike or wall of igneous rock. (Barrowman)

Whin float (Scot.). A kind of greenstone, basalt, or trap, occurring in coal measures. (Gresley)

Whin gaw (Scot.). A narrow dike of whin. (Barrowman)

Whinny. Resembling or abounding in whinstone. (Standard)

Whinsill (No. of Eng.). A sill or intrusive sheet of whinstone, especially one of great extent. (Webster)

Whinstone (Scot. & Eng.). Basaltic rock; also, among miners, any of various other dark resistant rocks, as chert or diabase (Webster). Greenstone.

Whip. 1. The simplest horse-power hoisting machine, consisting of a fixed pulley and a hoisting rope passing over it, to which the animal is directly attached (Raymond). When used with a derrick or gin called Whip-and-derry.
2. One who operates such a hoisting apparatus. (Standard)

Whip-and-derry. *See* Whip, 1.

Whip gin. A gin-block for use as a whip, as in hoisting (Standard). *See* Whip, 1.

Whipper. One who raises coal, merchandise, etc., with a whip, as from a ship's hold (Standard). *Compare* Coal whipper.

Whipping. 1. The thrashing about of a moving rope, as a hoisting cable in a mine shaft. *See* Surging. 2. Hoisting ore, coal, or other material by means of a Whip, 1.

Whipping hoist. A hoist worked with a whip, especially if by steam power. (Standard)

Whipsy-derry. 1. (Eng.) A whip-and derry. (Standard).
2. *See* Derrick, 2.

Whirley (Scot.). A hutch, hurley, or tub. (Barrowman)

Whirling table. A potter's wheel. (Webster)

Whisket (Eng.). A shallow, oval, coal basket. (Hunt)

Whistler. *See* Squealer.

White agate. Same as Chalcedony.

White alkali. 1. Refined soda ash. 2. A mixture of alkaline salts forming a white deposit on soil. (Webster)

White antimony. The mineral valentinite, Sb_2O_3. (Dana)

White arsenic. Arsenolite; arsenious oxide, As_2O_3. (Dana)

White-ash coal. Coal leaving a white ash. (Chance)

White Bengal fire. A very brilliant light produced by means of pure metallic arsenic. (Century)

White brass. An alloy of copper and zinc, with a comparatively small portion of copper. (Webster)

White bronze. A light-colored variety of bronze due to increased proportion of tin. (Standard)

White coal. 1. Water power; first so called by the French (*houille blanche*). 2. Tasmanite. (Webster)

White cobalt. A name frequently applied to smaltite; also to cobaltite.

White copper. A white alloy of copper. *See* Paktong (Webster). Usually German silver.

White copperas. 1. The mineral coquimbite. 2. The mineral goslarite. (Webster)

White damp. Carbon monoxide, CO. A gas that may be present in the afterdamp of a gas- or coal-dust explosion, or in the gases given off by a mine fire; also one of the constituents of the gases produced by blasting. Rarely found in mines under other circumstances. It is an important constituent of illuminating gas, supports combustion, and is very poisonous.

White furnace. *See* Howell furnace.

White garnet. Leucite. (Power)

White gunpowder. A blasting compound formed of potassium chlorate, potassium ferrocyanide and sugar. (Standard)

White horse. 1. (Scot.) Intruded white trap in a coal seam. (Barrowman)
2. A term used by quarrymen to denote a light-colored gneiss, aplite or pegmatite. (Perkins)

White-hot. Heated to full incandescence so as to emit all the rays of the visible spectrum, in such proportion as to appear dazzling white. (Century)

White-Howell furnace. A revolving, cylindrical furnace for calcining calmaine. *See* Oxland and Hocking furnace. (Ingalls, p. 124)

White iron. 1. A hard crystalline cast iron containing combined carbon. 2. Tinned sheet iron. (Standard)

White iron-ore. An early name for siderite. (Chester)

White iron-pyrite. *See* Marcasite.

White latten. An alloy of copper, zinc, and tin, in thin sheets. (Standard)

White lead. A pigment composed of approximately 75 per cent lead carbonate and 25 per cent hydrated lead oxide. (Standard)

White lead-ore. The mineral cerussite, $PbCO_3$. (Power)

White metal. 1. The product of the fourth stage of the English method of smelting copper ores (Standard). Contains 77 to 79 per cent copper.
2. Any one of several white alloys, as pewter, britannia, etc. Also frequently applied to silver as contrasted with gold, the yellow metal.

White mineral-press. A machine for briquetting flue dust. (Hofman, p. 404)

White mundic. Arsenopyrite or mispickel.

White nickel. A synonym for both Rammelsbergite and Chloanthite. (Chester)

Whitening. Tin-plating. (Standard)

White oil. An odorless and colorless oil possessing a specific gravity of 0.857. It is used medicinally and as a base for creams, salves, and ointments. *See* Oil of paraffin; Petrolatum. (Bacon)

White olivine. The mineral fosterite, Mg_2SiO_4. (Power)

White pyrite. Same as Marcasite. (Standard)

White rent (Local Eng.). An annual tax of eightpence upon every tinner in Cornwall and Devon, paid to the lord of the soil, formerly to the Prince of Wales as Duke of Cornwall. (Standard)

White rock. A dolerite of nearly white color associated with coal in Staffordshire and elsewhere. (Power)

White salt. Salt dried and calcined; decrepitated salt. (Webster)

White schorl. The mineral albite. (Standard)

White silver-ore. An old name for argentiferous tetrahedrite. (Chester)

Whitestone. 1. (Aust.) An indurated clay band in the Greta seam, thickly strewn with plant impressions. (Power)
2. A literal translation of the German *Weisstein*, the name of a rock now generally known as granulite, but sometimes called leptinite. (Century)

White tellurium. The mineral sylvanite, $(Au,Ag)Te_2$. (Chester)

White tin. Metallic tin after smelting, in contradistinction to *black tin* or cassiterite. (Power)

White tombac. A variety of brass made white by the addition of arsenic. (Standard)

White ultramarine. A white substance obtained when the ingredients used in the manufacture of artificial ultramarine are heated with access of air. (Standard)

White vitriol. Zinc sulphate; goslarite. Also called Salt of vitriol; Zinc vitriol.

Whitewash. A white scum of soluble sulphates which accumulates on the surface of a brick or other clay product during or after manufacture. (Ries)

Whiting. A white levigated and washed chalk used as a pigment and for polishing. According to its quality, it is known variously as *Spanish white* or *whiting* and *Paris white*. (Standard)

Whitneyite. A pale reddish-white copper arsenide, Cu_3As (As 11.6 per cent). (Dana)

Whits; Witts (Corn.). *See* Tin-witts.

Whitwell stove. A fire-brick hot-blast stove, on the regenerative system. (Raymond)

Whole; Whole mine. 1. (No. of Eng.) That portion of a coal seam being worked by driving headings into it only, or the state of the mine before mining the pillars. (Gresley) 2. (Derb.). Any ore that has not been mined. (Hooson)

Whole coal (Eng.). A district of coal entirely intact (G. C. Greenwell). *See* Virgin coal.

Whole cradle (No. of Eng.). A working platform or scaffold of nearly the same diameter as the shaft, and suspended from the surface. (Gresley)

Whole flat (No. of Eng.). A panel or district in which headings have been driven, prior to mining the pillars. (Gresley)

Whole stalls (So. Wales.) Two or more stalls having their faces in line or on a cleat with one another. (Gresley)

Whole-working (Newc.). Working where the ground is still whole, *i. e.*, has not been penetrated as yet with breasts. Opposed to pillar-work, or the extraction of pillars left to support previous work (Raymond). *See* Whole flat.

Whorled (Scot.). The cage is said to be whorled when it is drawn up to or over the pulleys. (Barrowman)

Whorler. A potter's wheel. Also called Whirler. (Standard)

Whorls (Scot.). Pithead or shaft pulleys. (Barrowman)

Whunstane (Scot.). Same as Whinstone.

Wich; Wych. Celtic for salt-spring; often used in England as the termination of names of places where salt is or has been found, as Droit*wich*, Nant*wich*, etc. (Oldham)

Wichtisite. A glassy phase of diabase, named from a Finland locality, Wichtis. *Compare* Sordavalite. (Kemp)

Wicket; Wicket work (No. Wales). A kind of pillar-and-stall, or bord-and-pillar, system of working a seam of coal, with pillars up to 15 yards and stalls up to 24 yards wide. (Gresley)

Widemouth socket. A well borer's fishing tool, in which the socket is fitted with a bellmouth, nearly the full bore of the casing, thus making it easy to grip the ends of broken poles or the like, when lost at the bottom of a well. (Nat. Tube Co.)

Wide-work. 1. (Eng.) A form of the pillar-and-breast method of excavating coal (Standard). 2. Room or chamber driving, as distinguished from entry or gangway driving or narrow work.

Widowmaker. *See* Rock drill.

Width. The thickness of a lode measured at right angles to the dip. (Skinner)

Wiggletail. *See* Rock drill.

Wildcat. 1. To act or carry on recklessly or wildly. 2. Originated or characterized by wild, irresponsible speculation; unreliable or unsafe by reason of reckless financiering; as, a *wildcat* bank. (Standard). 3. A mining company in which the management raises money, often by exaggerated and misleading statements, intending to use the funds so raised for personal profit rather than for the development of the property and without regard to securing an adequate return to the investors. A malign intent is not a necessary

characteristic, for the term is now used as follows: 4. Specifically applied to a mining or oil company organized to develop unproven ground far from the actual point of discovery. Any risky venture in mining.

Wildcatter. 1. (U. S.) One who drills wells in the hope of finding oil in territory not known to be an oil field (Webster). 2. One who locates a mining claim far from where ore has been discovered or developed. 3. One who organizes or assists in the organization of a wildcat. *See* Wildcat, 3 and 4.

Wildcatting. 1. Drilling wells for oil in territory not yet proven to be oil bearing. 2. Locating mining claims outside of well-developed, or known mineral deposits, or far from the actual point of discovery. 3. Organizing and exploiting a risky venture. *See* Wildcat, 3 and 4.

Wild coal. Brittle slate interstratified with thin coal seams. Also called rashings. The roof of the Pitsburgh seam in western Maryland. (Md. Geol. Surv., vol. 5, p. 534)

Wildfire. (Eng.). An old term used by colliers for fire damp. (Gresley)

Wild gas. Blast-furnace gas that does not burn steadily or properly. (Willcox)

Wild heat (of Steel). A heat of molten steel which is boiling violently, and so, if poured, honeycombs the ingot with contained gases (Webster). *See also* Heat, 2.

Wild lead. Zinc blende. (Raymond)

Wild steel. Steel made from a wild heat, which *see*. (Webster)

Wild well. An oil well, the flow of which cannot be brought under control. (Redwood, p. 244)

Wild work. A kind of bord-and-pillar system of coal mining in which the very narrow pillars left to support the roof are not recovered. (Webster)

Willey slimer. A form of shaking canvas table which is given a vanner motion. (Liddell)

Willey table. A side-jerk table used in ore-dressing. It has a riffled surface which separates the light and heavy grains into layers by agitation, and the jerking action then throws the heavy grains toward the head end, while the light grains are washed down over the cleats into the tailings box. The table tapers toward the head end, and the riffles are progressively longer toward the tailings side. The Dodd, Cammett, Hallett and Woodbury are similar types. (Liddell)

Willemite Zinc silicate, Zn_2SiO_4. Contains 58.6 per cent zinc. The zinc is commonly replaced in part by manganese. (U. S. Geol. Surv.)

Williams hinged-hammer crusher. A crusher with a rotating central shaft carrying a number of hinged hammers, which fly out from centrifugal force, crushing the feed against the casing. (Liddell)

Williamsite. An apple-green impure variety of serpentine. *See* Jade. (U. S. Geol. Surv.)

Willow pattern. In pottery, a design used in decorating china, originally, the blue china of Nanking, introduced in English porcelain about 1780. (Webster)

Wilson producer. A furnace used for the manufacture of producer gas. (Ingalls, p. 323)

Wiluite. 1. A variety of vesuvianite. (Dana)
2. A green aluminum garnet. (Standard)

Wimble (Eng. and Scot.). A hollow instrument for cleaning a hole in boring; a kind of shell auger. Some varieties of wimble, suitable for boring into soft clay, are called Wimble-scoops (Century). Also spelled Wammel, Whimble, Wumble.

Wimble-scoop. *See* Wimble.

Win. 1. To extract ore or coal (Raymond). To mine, to develop, to prepare for mining. (Century)
2. To recover metal from an ore. (Webster)

Winch; Windlass. A man-power hoisting machine, consisting of a horizontal drum with crank handles (Raymond). Also, now operated by steam, as a steam winch.

Wind. 1. (Eng.) A hand-windlass or jack-roll. 2. To raise coal, etc., by means of a winding-engine. 3. A steam engine used purposely for lowering and raising men in an engine pit or pumping shaft. 4. A single journey of a cage from top to bottom of a shaft, or vice versa. (Gresley)

Wind blast. 1. (Aust.) A quantity of air driven out of mine workings with considerable force by a fall of roof. (Power)
2. A blown-out or "windy" shot.

Windbore (Newc.). The suction pipe at the bottom of a set of pumps (Raymond). *See* Snore piece; *also* Snore hole.

Wind furnace. Any form of furnace using the natural draft of a chimney without the aid of a bellows or blower. (Duryee)

Wind gage. An anemometer for testing the velocity of the air in mines. (Gresley)

Wind hatch. In mining, an excavation or opening for removing ore. (Standard)

Windhole (Eng.). A shaft or other opening for ventilation. (Bainbridge)

Winding. Hoisting coal or ore with a rope wound on a drum; used synonymously with Hoisting. (Chance)

Winding bar. The appliance on drop bottom ore or coal cars by which the doors are closed and held tight.

Winding engine (Eng.). The apparatus fixed within a few yards of the mouth of a shaft for raising the minerals from the bottom, or from various levels, to the surface (Gresley). A hoisting engine; a hoist.

Winding rope. The rope, or cable, which connects the cage with the drum of the winding engine.

Windlass. A roll or drum with handles, used in winding or hoisting from shallow pits.

Windless (Derb.). A place in the mine where the air is bad or short. Also called Airless. (Min. Jour.)

Wind method. A system of separating coal into various sizes, and extracting waste from it, which in principle depends on the specific gravity or size of the coal and the strength of the current of air. (C. and M. M. P.)

Wind road (Eng.). An air passage for mine ventilation.

Windrow. A row of peats or sod set up to dry, or cut in paring and burning. (Standard)

Winds. A variation of winze.

Wind sail. The top part of canvas piping, which is used for conveying air down shallow shafts. (C. and M. M. P.)

Wind wall. *See* Bridge, 1.

Wind way (So. Staff.). An airway leading from one road to another. (Min. Jour.)

Windy shot. A blast in coal mines which, due to improperly placed charges, wrong kind or quantity of explosives, or insufficient stemming expends most of its force on the mine air, and sometimes ignites a gas mixture, coal dust, or both, thus causing a secondary explosion which may or may not spread throughout the mine.
A shot which blows out without disturbing the coal (Athens Min. Co. *v.* Carnduff, 123 Illinois App., p. 183.) A shot that is not properly directed or loaded. (Bolen-Darnell Coal Co. *v.* Hicks, 190 Fed. Rept., p. 720). A blown-out shot.

Wing (Scot.). The point plate of a tram crossing. (Barrowman)

Wing bore (Scot.). A side or flank bore-hole in a working place approaching old workings. (Barrowman)

Wing dam. A dam built partly across a river to deflect the water from its course. (Duryee)

Winged pillars (Scot.). Pillars of coal that have been reduced in size. (Barrowman)

Wings. 1. The sides, or limbs, of an anticline. *See* Legs. (Power)
2. Same as Rests, Keeps, Chairs, Dogs.

Winning. 1. A new mine opening. 2. The portion of a coal field laid out for working. (Raymond)
3. Mining.
4. (Scot.) A pit (mine) and its associated equipment and machinery. (Barrowman)

Winning bord (Aust.). A room from which coal is being mined. (Power)

Winning headway. 1. (Newc.) A headway driven to explore and open out the coal seam. (Raymond)
2. (No. of Eng.) A cross-heading, or one driven at right angles to the main gangway (Century)

Winning-off (Aust.). A leading heading or drive in advance from which rooms, or bords, are opened. Any leading drift is termed a "winning." (Power)

Winning pillars (Aust.). Extracting coal pillars. (Power)

Winnowing gold. Air-blowing. Tossing up dry powdered auriferous material in air, and catching the heavier particles not blown away. (C. and M. M. P.)

Winooski marble. A siliceous dolomite of a mottled chocolate, red, pink, yellow, and white color, and used as a marble for tiling and wainscoting; from Mallett's Bay, on Lake Champlain. (Merrill)

Win out (Scot.). To widen out, as where long wall working is being commenced. (Barrowman)

Winter dumps (Alaska). Gold-bearing gravel mined during the winter and stored on the surface for sluicing in the spring and summer.

Winter oil. A heavy railway-car and engine oil which has a solidifying point of below —20° F. (Bacon)

Winze. A vertical or inclined opening, or excavation, connecting two levels in a mine, differing from a raise only in construction. A *winze* is sunk underhand and a raise is put up overhand. When the connection is completed, and one is standing at the top, the opening is referred to as a winze, and when at the bottom, as a *raise*, or *rise*. *Compare* Underground shaft.

Wiper. 1. A rod on which is held a piece of cotton waste or other absorbent material and used for drying a drill hole before charging with black powder. (Gillette, p. 441)
2. A form of cam.

Wire. (War.) A haulage rope. (Gresley)

Wire bars. Refined copper bars cast into bars for wire drawing. (Weed)

Wire drawing. 1. The operation, accidental or otherwise, of reducing the pressure of steam between the boiler and the cylinder. (Ihlseng)
2. The act or art of extending ductile metal into wire. (Century)

Wire gage. 1. A gage for measuring the diameter of wire or thickness of sheet metal. 2. A standard series of sizes arbitrarily indicated by numbers, to which the diameter of wire or the thickness of sheet metal is usually made, and which is used in describing the size or thickness.

Wire gauze. A gauze-like texture of fine wire, as that used for the chimneys of flame safety-lamps.

Wire glass. Glass in which wire netting is embedded to increase its strength. (Webster)

Wire rod. A metal rod from which wire is drawn. (Webster)

Wire rope. A rope whose strands are made of wires, twisted or woven together. (C. M. P.)

Wire ropeway. A ropeway using a wire cable or cables. Used for conveying ore and supplies in rough mountainous districts; a wire tramway. *See* Aerial tramway.

Wire silver. Native silver in the form of wire or threads. (Webster)

Wire tramway. *See* Aerial tramway.

Wisket; Whisket (Lanc.). A light basket weighing about 25 pounds, used for carrying coal, etc., up a shaft. (Gresley)

Witchet (No. Wales). *See* Wicket.

Withamite. A red to yellow variety of epidote, containing a small quantity of manganese. (Standard)

Witherite. Native barium carbonate $BaCO_3$. (Dana)

Witness corner. A post set near a corner of a mining claim with the distance and direction of the true corner indicated thereon. Used when the true corner is inaccessible. (Shamel, p. 321)

Witts. *See* Tin-witts.

Wohlwill process. An electrolytic process of gold refining, using impure gold bullion as anodes and sheet gold cathodes in a solution carrying 25–30 ounces free HCl (specific gravity 1.19) per cubic foot. If the anodes contain lead some H_2SO_4 is added. The current density is about 100 amperes per square foot, the potential 1 volt. The tanks usually used are porcelain. Patinum and the allied metals remain in the electrolyte, the silver settles out as chloride. (Liddell)

Wolchonskoite. An amorphous, dull, bluish-green, fragile chromiferous clay. (Standard)

Wolf process. A flotation process invented by Jacob D. Wolf in 1902. He used sulphochlorinated or other oils and aimed to secure a high extraction with a low grade of concentrate in the first step, and by washing with hot water to concentrate the concentrate in a second step. Apparently no commercial use was made of it. (Liddell)

Wolfram. 1. (Ger.) A native tungstate of iron and manganese; *See* Wolframite.
2. The metal tungsten or wolframium: An improper and now uncommon use. (Century)

Wolframinium. A light aluminum alloy similar to Romanium. (Webster)

Wolframite. A series of minerals composed of tungstate of iron and manganese, $(Fe,Mn)WO_4$, containing, when the iron and manganese are in a ratio of 1 to 1, 76.4 per cent WO_3. As the iron increases and the manganese decreases wolframite grades into ferberite, the iron tungstate, $FeWO_4$, with 76.3 per cent WO_3. At the other end of the series is hübernite, the pure manganese tungstate, containing 76.6 per cent WO_3. (U. S. Geol. Surv.)

Wolframium. Tungsten: the scientific name. (Standard)

Wolfram lamp. A tungsten lamp. (Webster)

Wolfram ocher. The mineral tungstite, WO_3. (Webster)

Wolfram steel. Same as Tungsten steel. (Standard)

Wolfsbergite. 1. Same as Chalcostibite. (Dana)
2. Same as Jamesonite. (Standard)

Wollastonite. A white mineral of the pyroxene group consisting of silicate ($CaSiO_3$) of calcium and a common product of the metamorphism of limestone by intrusive igneous rocks. Often in aggregates of flat prismatic crystals without distinct crystal planes or faces. (Ransome)

Won (Eng.).. Proved, sunk to, and tested. Coal is won when it is proved and so developed that it can be worked and conveyed from the mine. (Gresley)

Wonder stone. A variety of stone consisting of yellow crystals of calcite disseminated through dark-red earthy dolomite. (Standard)

Wood. 1. (Eng.) Signifies mine timbers, bars, sprags, chocks, lagging, etc., which are all used in various ways for supporting the roof and sides of underground workings. (Gresley)
2. Agatized, opalized, petrified, silicified wood; a material composed of opal or chalcedony (agate) and formed by the replacement of wood by silica. The replacement of the woody matter by the silica takes place in such a way that the original form and structure of the wood is preserved. (U. S. Geol. Surv.)

Wood agate. Agate formed by the petrification of wood. *See* Wood, 2.

Woodbury jig. A jig with a plunger compartment at the head end, so that the material is given a classification in the jig. (Liddell)

Woodbury table. A table of the general Wilfley-Overstrom-Card type, with riffles parallel to the tailings side, and a hinged portion without riffles (unlike the Card). The table top is a rhomboid, and the riffles gradually shorten as they near the tailings side. (Liddell)

Wood chain (So. Staff.). A hoisting chain, the iron links of which are filled with small blocks of wood. (Gresley)

Wood coal. 1. Lignite. *See* Board coal. 2. Charcoal. (Webster)

Wood copper. A fibrous olivenite. (Dana)

Wooders (York). Timbermen employed in mines. (Gresley)

Wood hematite. A finely radiated variety of hematite, exhibiting alternate bands of brown or yellow of varied tints. (Power)

Wood iron. A fibrous variety of chalybite (siderite), $FeCO_3$. (Power)

Wood opal. A variety of opal consisting of wood in which the organic matter has been replaced by silica; silicified wood. Called also Xylopal. (Standard)

Wood peat. Peat formed from decayed wood, leaves, etc., in forests. (Standard)

Wood process. A flotation process utilizing the surface tension of water, either fresh, acid, or salt. (Megraw, p. 73)

Wood ringer (Eng.). *See* Ringer 1; and Dog and chain, 1. (Gresley)

Woodrock. A variety of asbestos resembling wood. (Standard)

Woodstone. Petrified wood, as wood opal. (Standard)

Wood tin. A nodular variety of cassiterite, or tinstone, of a brownish color and fibrous structure, and somewhat resembling dry wood in appearance. (Century)

Woolpack. (Eng.). A concretionary mass of crystalline limestone occurring in the form of balls, varying greatly in size, in the Wenlock limestone. Called also Ballstone. (Standard)

Wootz. 1. A variety of steel made in India by the cementation process: the earliest known form of steel (Standard). Prepared from a black iron ore of Hindustan by a process analogous to the Catalan hearth. (Ure)

Work. 1. (Mid.) A stall or working place in a mine. 2. (Eng.) To get, cut away, or excavate and remove any bed or seam, or part thereof, of coal, ironstone or other mineral, whether underground or in open work. To mine. 3. (So. Staff.) A side of work, *which see.* (Gresley)
4. To crumble and yield under the action of a squeeze. Applied to pillars or roof of a coal mine. 5. To be slowly closing under the action of a squeeze. Applied to portions of the mine workings. (Steel)
6. Ore before it is dressed. 7. A place where industrial labor of any kind is carried on. Usually in the plural as a *salt works, iron works,* etc. (Webster)

Workable beds, or veins. Any bed or vein that is capable of being worked, but usually applied to that coal seam or ore deposit which can be mined profitably.

Worked-out. Exhausted (Chance). Said of a coal seam or ore deposit.

Working. 1. *See* Labor, 1. The Spanish and the English terms are synonymous in meaning and alike in application. A working may be a shaft, quarry, level, opencut, or stope, etc. (Raymond). Usually used in the plural. *See* Workings.
2. (Scot.) A name given to the whole strata excavated in working a seam. 3. (Scot.) Making a noise before falling down, such as holed coal at the face, or unsupported roof strata (Barrowman). *Compare* Work, 4 and 5.

Working barrel (Corn.) The cylinder in which a pump piston works. (Raymond)

Working beam (Eng.) A beam having a vertical motion on a rock shaft at its center, one end being connected with the piston rod and the other with a crank or pump rod, etc. A walking beam (C. and M. M. P.). Also, a brake staff.

Working big (Eng.). Said of a vein large enough for a man to work in without breaking any of the adjacent rock.

Working drawing. A drawing or plan, as of the whole or part of a structure or machine, drawn to a specified scale, and in such detail as to form a guide for the construction of the object represented. (Century)

Working face. The place at which the work is being done in a breast, gangway, airway, chute, heading, drift, adit, or crosscut, etc. (Chance). *See* Face.

Working first (Aust.). *See* Whole-working.

Working furnace (Eng.). A mine-ventilating furnace supplied with fresh air from the downcast shaft. (Gresley)

Working home. Working toward the main shaft in extracting ore or coal, as in longwall retreating (Raymond). *See* Longwall method.

Working load. The maximum load that a rope can carry under the conditions of working without danger of straining. Same as Proper working load. (C. M. P.)

Working-on-air. A pump works on air when air is sucked up with the water. (C. and M. M. P.)

Working-on-the-walls. The eroding or corroding of blast furnace lining. (Willcox)

Working out. Working away from the main shaft in extracting ore or coal, as in longwall advancing. (Raymond.) Compare Working home.

Working pit. A mine shaft up which the ore and miners are carried, as distinguished from one used only in pumping. (Standard)

Working place. The place in a mine at which coal or ore is being actually mined (Steel). *See also* Working face.

Working plan. Same as Working drawing.

Working rate. (Scot.). The rate per ton paid to a miner. (Barrowman)

Workings. Any species of development; usually restricted in meaning to apply to the breasts, etc., in contradistinction to the gangways and airways. Often used in a broader sense to mean all the underground developments (Chance). *See* Working, 1.

Working-the-broken (Aust.). The process of removing the pillars in bord-and-pillar work (Power). Same as Second working; Robbing pillars.

Work-lead. Impure pig lead that is to be desilverized or refined (Standard). *See* Base bullion.

Work stone. A plate in the bottom of a blast hearth or ore hearth having a groove down its center for conducting away the molten lead. (Standard)

Work-the-twig (Prov. Eng.). To use the divining rod. (Standard)

Worm; Worm coil (Eng.). A spiral tool, used for loosening tough clays at the bottom of bore holes. *See* Wad coil. (Gresley)

Worming pot. In ceramics, a vessel that discharges color through tubes, for forming strips or worm-like patterns on an article of pottery rotated in a lathe. (Standard)

Wough (Scot.). A wall; the rock beside a vein of lead ore. (Webster)

Wreath. In glass-making, a wavy appearance in glass, especially flint glass, due to defective manufacture. (Standard)

Wreaths (Leic.). Four short pieces of hemp rope placed around the legs of a horse or pony and fastened together above its back, by which it was formerly lowered into or brought up out of a mine. (Gresley)

Wreck (Scot.). A breakdown, as in a shaft or on an incline. (Barrowman)

Wrought iron. The purest form of iron commonly known in the arts, containing only about half of 1 per cent of carbon. It is made either directly from the ore, as in the Catalan forge or bloomery, or by purifying (puddling) cast iron in a reverberatory furnace or refinery. (Webster)

Wrought steel. Weld steel. (Webster)

Wulfenite. Lead molybdate, $PbMoO_4$. Contains 39.3 per cent MoO_3. Calcium, chromium, copper, and vanadium are sometimes constituents. (U. S. Geol. Surv.)

Wurtzilite; Elaterite; Tabbyite; Æonite; Ægerite. An asphaltic mineral which is jet-black by reflected light and deep-red in thin plates. It softens in hot water, toughens, and becomes more elastic. In a candle flame it softens and burns with a bright flame. It is practically insoluble in gasoline of 76° Bé., partly soluble in ether, carbon disulphide, and turpentine, and less so in carbon tetrachloride. (U. S. Geol. Surv.)

Wurtzite. A zinc sulphide of the same composition as sphalerite, ZnS, but hexagonal in its crystallization. (U. S. Geol. Surv.)

Wych. *See* Wich.

Wye (Cumb.). The beam-end connection above the pump-rods of a winding and pumping engine. (Gresley)

Wyomingite. An aphanophyric igneous rock containing leucite, diopside, and phlogopite in a glassy base of much the same composition as orthoclase (La Forge). From the Lucite Hills, Wyoming. This rock was described by Zirkel in 1876 and was the first known occurrence of leucite in America. (Kemp)

Wythern (Eng.). A vein or lode. (Power)

X.

Xacal (Mex.). A miner's cabin; a storehouse for mining supplies; a shaft house (C. and M. M. P.). Also spelled Jacal.

Xalsonte (Sp.). A coarse pay sand or gravel. (Lucas)

Xanthitane. An alteration product of sphene (titanite). Its composition is analogous to the clays, but contains chiefly titanic oxide instead of silica.

Xanthite. A yellowish variety of Vesuvianite. (Webster)

Xanthoconite. Silver-arsenic sulphide, $3Ag_2S.As_2S_3$. Contains 61.4 per cent silver. (U. S. Geol. Surv.)

Xanthophyllite. A hydrous silicate of magnesium, calcium, and aluminum, occurring in crusts or in implanted globular forms. (Dana)

Xanthorthite. A yellow altered variety of allanite that contains considerable water. (Standard)

Xanthosiderite. A hydrated oxide of iron, $Fe_2O_3.2H_2O$, occurring in fine needles or fibers, stellate and concentric; also as an ocher. Golden-yellow to brown. (Dana)

Xenogenites. Posepny's term for mineral deposits of later origin than the wall rock. The name means foreigners, and refers to their later introduction. *Compare* Idiogenites. (Kemp)

Xenolite. A silicate of aluminum, related to fibrolite. (Century)

Xenolith. A fragment of other rock or of an earlier solidified portion of the same mass inclosed in an igneous rock; an inclusion; an enclave. (La Forge)

Xenomorphic. Rohrbach's textural, name for those minerals in an igneous rock, whose boundaries are determined by their neighbors. Its antithesis is automorphic, which *see*. Xenomorphic is synonymous with allotriomorphic, over which it has priority. (Kemp)

Xenon. A very heavy inert gaseous element occurring in the atmosphere in the proportion of one volume in about 20 millions. Symbol, X; atomic weight 130.2; specific gravity, 3.52. (Webster)

Xenotime. Essentially an yttrium phosphate, YPO_4. Cerium and Erbium are sometimes present, also silicon and thorium as in monazite. (Dana)

X-frame brace. A reinforcement bracing of a square-set in which two diagonal pieces of timber cross to form an X. (Sanders, p. 49)

Xihuitl (Mex.). Turquois found by the Aztecs near the City of Mexico. (Halse)

Xilópalo (Sp.). Wood opal. (Halse)

Xonalite. A hydrous silicate of calcium, occurring in massive forms of a white or bluish gray color. (Century)

Xylanthrax. Wood-coal; charcoal: so called in distinction from mineral coal. (Standard)

Xyloidine. An explosive compound produced by the action of nitric acid upon starch or woody fiber, resembling gun cotton. (Century)

Xylopal. *See* Wood opal.

Y.

Yacente (Sp.). Foot-wall, or floor of an ore deposit. (Halse)

Yacimiento (Sp.). 1. A mineral deposit. *See* Criadero. 2. The occurrence or mode of occurrence. (Halse)

Yankee. In founding, a molder's lifting-tool having a curved shank. (Standard)

Yanolite. Same as Axinite. (Standard)

Yardage. 1. Price paid per yard for mining coal. 2. The extra compensation a miner receives in addition to the mining price for working in a narrow place or in deficient coal. Usually at a certain price per yard advanced. (Steel)

Yard price. The price paid per yard driven (in addition to the tonnage prices) for roads of certain widths, and driven in certain directions (C. and M. M. P.). *See* Yardage.

Yard service. Transportation of rock from the quarry bank until the time it reaches the main transportation lines. (Bowles)

Yard work (Forest of Dean). Synonymous with Yardage. (Gresley)

Yareta (Bol., Chile, and Peru). A resinous moss found at high elevations, and used as a fuel. (Halse)

Yark (Derb.). To jerk a rope or other appliance used for lifting or drawing. (Gresley)

Yed (Leic.). *See* Head, 1.

Yellow arsenic. Orpiment. (Chester)

Yellow copper. Chalcopyrite.

Yellow copperas. *See* Copiapite.

Yellow earth. Specifically, yellow ocher. (Webster)

Yellow lead-ore. Wulfenite. (Webster)

Yellow metal. 1. Gold. 2. Muntz metal. (Webster)

Yellow ocher. A soft earthy variety of limonite. (Power)

Yellow ore (Corn.). Chalcopyrite. (Raymond)

Yellow orpiment. King's yellow, As_2S_3. (Webster)

Yellow ozokerine. A product resembling vaseline, but less homogeneous, produced from crude ozocerite. (Bacon)

Yellow pyrite. Same as Chalcopyrite. (Standard)

Yellow ratebane. Orpiment. (Webster)

Yellow ultramarine. A pigment consisting of barium chromate. (Standard)

Yellow wax. A viscous, semi-solid, difficultly volatile substance obtained on distillation of petroleum-still residuum. (Bacon)

Yelmo (Mex.). Coke fork. (Dwight)

Yenite. *See* Ilvaite.

Yentnite. A name derived from the Yentna River, Alaska, and suggested by J. E. Spurr for certain granitoid rocks, consisting of oligoclase, acapolite, and biotite, with a few zircons. The acapolite is believed to be an original mineral. (Kemp)

Yeso (Sp.). 1. Gypsum mineral. 2. Calcined gypsum; *Y. blanco*, whiting; *Y. mate*, plaster of Paris. (Halse)

Yesosos (Aguas, Mex.). Copper ore in which calcite or fluorspar predominates as a matrix. (Halse)

Yield. 1. The proportion of coal or ore obtained in mining; the product of a metallurgical process; extraction; recovery. 2. To give way; to crush. Said of pillars of coal when they commence to give way or crush. (Gresley)

Y-level. A level mounted in a pair of Y's: a common form of spirit-level, used in surveying, etc.

Yodo (Sp.). Iodine. (Lucas)

Yogoite. A name suggested by Weed and Pirsson from Yogo peak, one of the Little Belt Mountains, Mont., for a syenitic rock (monzonite) composed of orthoclase and augite in about equal amount. *See also* Sanidinite and Shonkinite. (Kemp)

Yoking. 1. (Eng.) A collision of mine cars. (G. C. Greenwell) 2. In the plural, stakes placed at regular intervals for the purpose of marking the boundaries of a mining claim. (Standard)

Yolk coal; Yolks (Scot.). Free or soft coal. (Barrowman)

Yoredale rocks (Eng.). The upper beds of the English Carboniferous limestone series, or those lying between the Carboniferous limestone proper and the millstone grit. They contain celebrated lead-mines. (Standard)

Yorkshire stone. A building stone of the English millstone grit. (Standard)

Young; Youthful. Being in the stage of increasing vigor and efficiency of action: said of some streams; also, being in the stage of accentuation of and a tendency toward complexity of form: said of some topography resulting from land sculpture. Contrasted with Mature and Old. (La Forge)

Young river. In geology, a river which has begun to form a drainage system in newly raised or newly deformed land. It is characterized by a shallow ungraded channel bordered by numerous lakes; by having but few short tributaries; and from variation in the hardness of its bed rocks, by frequent waterfalls.

Youstone (Eng.). An old term for Chinese jade, or nephrite. (Page)

Youth. That stage in the development of streams when they are increasing in vigor and efficiency; or in land sculpture when topographic forms are being accentuated and are tending toward complexity; contrasted with Maturity and Age. (La Forge) *See also* Young.

Y-track. A track at approximately right angles to a line of railroad, and connected with it by two switches, the plan of the whole approaching the form of a Y with a line joining the ends of its arms: used in place of a turntable. (Standard)

Ytterbite. Same as Gadolinite.

Ytterbium; Neoytterbium. A rare metallic element closely resembling yttrium. It has a valence of three. Symbol, Yb; atomic weight, 173.5. (Webster)

Yttergranat. A calcium-iron garnet containing a small amount of yttria. (Dana). A variety of andradite.

Yttrialite. A silicate of thorium and the yttrium metals chiefly, but it contains also uranium and other elements in small quantity. (U. S. Geol. Surv.)

Yttrium. A trivalent metallic element found (combined) in gadolinite and other rare minerals. Symbol, Y; atomic weight, 89.0. (Webster) Obtained as a dark-gray powder possessing a metallic luster under a burnisher. It decomposes water slowly in the cold but more quickly on boiling.

Yttrium-garnet. A variety of garnet containing a small amount of yttrium earths. *See* Yttergranat. (Century)

Yttrocerite. A hydrous fluoride of cerium, yttrium, erbium, and calcium. (Dana)

Yttrotantalite. A tantalate and niobate of iron, calcium, yttrium, erbium, cerium, etc., occurring in black-brown orthorhombic crystals (Dana). Called also Yttrocolumbite.

Yu (China). Jade. Called also Yuh; Yustone (Standard). *See* Youstone

Yungas (Bol.). A region of low plains; an alluvial basin, often containing rich placers. (Halse)

Yunque (Mex.). Anvil. (Dwight)

Z.

Zacate (Mex.). Fodder for animals, as hay, cornstalks, etc (Dwight)

Zaccab. A kind of white earth mixed with lime used by the natives of Yucatan for plaster, stucco, etc. (Webster)

Zaffer; Zaffre. An impure oxide of cobalt obtained by a roasting process in which the sulphur and arsenic are driven off. (Humble)

Zaffer-blue. Same as Cobalt-blue.

Zafirina (Sp.). Blue chalcedony. (Halse)

Zafiro (Sp.). 1. Sapphire. 2. Ultramarine; lapis lazuli. (Halse)

Zafra. 1. (Sp.) Gangue; matrix. 2. The sugar crop in Cuba. (Halse)

Zafrero (Sp.). A workman occupied in handling waste rock. (Halse)

Zahino (Colom.). Timber used for shaft lagging. (Halse)

Zambullidor (Colom.). One who pans gravel with a large *batea*. (Lucas)

Zambullidora (Colom.). An oval pan with handle. A large *batea*. (Lucas)

Zambullir (Colom.). To extract the gold from the bottom of streams with a large *batea*. (Lucas)

Zapa (Colom.). A small intermediate level driven between two main levels. (Halse)

Zapapico (Sp.). A pickax; a mattock. (Halse)

Zapato (Sp.). A shoe or stamp; *Z. de freno*, a brake shoe. (Halse)

Zar (Persia). Gold. (C. G. W. Lock)

Zaranda (Sp.). 1. Large ore-screen; a grizzly. 2. A small sieve used in assaying. (Halse)

Zarandero (Mex.). One who attends the screen. (Dwight)

Zaratite. A massive, vitreous, emerald-green, hydrous nickel carbonate, $H_{12}Ni_5CO_{11}$. Occurs usually as an incrustation (U. S. Geol. Surv.). Also called Emerald nickel.

Zarnec; Zarnich. Native sulphide of arsenic, including sandarac and orpiment. (Webster)

Zaroche (Mex.). 1. Gold of low color containing silver. (Lucas) 2. (Ecuador) Mountain sickness. *See* Soroche, 1. (Halse)

Zarzo (Sp., Am.) Timbering; propping. (Lucas)

Zawn (Corn.). A cavern. (Raymond)

Zax. A tool for trimming and puncturing roofing slates. (Webster)

Zeasite. An old name for a variety of fire opal. (Chester)

Zebeb (Arabic). Gold. (C. G. W. Lock)

Zechstein (Ger.). The upper division of the Permian in Europe. (Webster)

Zefre (Sp.). A safety fuse. (Halse)

Zellweger furnace. A long-hearth reverberatory furnace used at Iola, Kans. (Ingalls, p. 112)

Zeolite. A generic term for a group of minerals occurring in cracks and cavities of igneous rocks, especially the more basic lavas. Zeolites are hydrous silicates of aluminum with either sodium or calcium or both, and rarely barium or strontium. Before the blowpipe most of the zeolites fuse readily and with strong intumescence, whence their name, derived from the Greek, for "boiling stone." They have little economic importance. (U. S. Geol. Surv.)

Zeolitization. The process by which a mineral is converted into zeolite by alteration, *e. g.* nepheline into thompsonite. (Century)

Zeuxite (Corn.). An obscure mineral, probably tourmaline. (Chester)

Zeylanite. *See* Ceylonite. (Standard)

Ziervogel process. The extraction of silver from sulphide ores or matte by roasting in such a way as to form sulphate of silver, leaching this out with hot water ,and precipitating the silver by means of metallic copper. (Raymond)

Zietrisikite. A brown, fossil wax resembling ozocerite. (Standard)

Zighyr; Zigger; Sicker (Corn.). To percolate, trickle, or ooze, as water through a crack. From the German, *sickern*. (Raymond)

Ziment water. Water impregnated with copper: found in copper mines. (Standard)

Zinc. 1. A bluish-white, crystalline, metallic substance. Not found native. Symbol Zn; atomic weight, 65.37; specific gravity, 7 to 7.2. 2. To coat or cover with zinc.

Zincaluminite. A light-blue, hydrated zinc sulphate, with zinc and aluminum hydrates, $Al_4Zn_4S_2O_{21},18H_2O$., that crystallizes in the hexagonal system. (Standard)

Zincblende. *See* Sphalerite.

Zinc bloom. *See* Hydrozincite; Zinc oxide.

Zinc box. A box containing zinc for the precipitation of gold from cyanide solutions. (Rickard)

Zinc colic. A form of colic thought to be caused by zinc-oxide poisoning. (Century)

Zinc dust. Finely-divided zinc, zinc-oxide, and impurities, incidentally produced in the manufacture of spelter. It is sometimes used as an inferior paint (zinc-gray). (Raymond)

Zinc gray. *See* Zinc dust.

Zinc green. Cobalt green. (Webster)

Zincing. The act or process of heating iron plate with zinc or zinc salts; galvanization. (Standard)

Zincite; Red oxide of zinc. Zinc oxide, ZnO. Contains 80.3 per cent zinc. (U. S. Geol. Surv.)

Zincolysis. A mode of decomposition occasioned by an electrical current; electrolysis. (Century)

Zincolyte. A body decomposable by electricity; an electrolyte. (Century)

Zinc ores. Zinc is not found native. *See* Calamine, Franklinite, Hydrozincite, Nicholsonite, Smithsonite, Sphalerite, Willemite, Wurtzite, Zincite. (U. S. Geol. Surv.)

Zinc oxide. A white pulverulent oxide ZnO, made by burning zinc in air. It is used as a pigment, chiefly as a substitute for white lead. Called also Flowers of zinc; Nihil album; Philosopher's wool; Zinc bloom; Zinc white. (Standard)

Zinc scum. The zinc-silver alloy skimmed from the surface of the bath in the process of desilverization of lead by zinc. (Raymond)

Zinc spar. An early name for Smithsonite. (Chester)

Zinc spinel. A synonym for Gahnite. (Chester)

Zinc sulphate. A compound, $ZnSO_4$, usually obtained by dissolving zinc in sulphuric acid, or by roasting and oxidizing certain zinc ores. (Webster)

Zinc vitriol. 1. A common name for goslarite (Chester). Zinc sulphate.

Zinc white. Oxide of zinc. (Raymond)

Zinkazurite. A mineral found in small, blue crystals, probably a mixture of sulphate of zinc and carbonate of copper. (Chester)

Zinkenite. A native lead-antimonite of sulphur, $PbSb_2S_4$ (Webster). *Also* Zinckenite.

Zinkite. Same as Zincite.

Zinnwaldite. An iron-lithia mica in form near biotite. Color pale violet, yellow to brown and dark gray. (Dana)

Zippeite. A basic sulphate of Uranium. (Century)

Ziquitumba (Colom.). Unwatering a a mine, by manual labor, the men carrying the water from one shaft or winze to another. (Halse)

Zircon. Zirconium silicate, $ZrSiO_4$. When clear and orange-colored it is used for the gem known as hyacinth. (U. S. Geol. Surv.) Also called Azorite.

Zirconia. Zirconium dioxide, ZrO_2.

Zirconium. A rare element found in combined form only. A grayish crystalline metallic substance. Symbol, Zr; atomic weight, 90.6; specific gravity. 4.15. (Webster)

Zircon light. A light similar to the calcium light, produced by incandescent zirconia. (Webster)

Zircon-syenite. A name originally given by Hausmann to certain Norwegian nephelite-syenites which were rich in zircons. Later it was practically used as a synonym for nephelite-syenite, but is now obsolete. (Kemp)

Zirkelite. 1. A name proposed by Wadsworth in 1887 to designate altered, basaltic glasses, in distinction from their unaltered or tachylitic state. (Kemp)
2. A variety of the thorium-bearing minerals. (Moses)

Zirlite. A light-yellow, aluminum hydrate, $Al(OH)_3$, that is found amorphous, and is closely related to gibbsite. (Standard)

Ziskon. A trade name for an alloy of aluminum and zinc, containing 25 per cent of the latter metal: used in making scientific instruments. (Century)

Zloto (Polish). Gold. (C. G. W. Lock)

Zobtenite. Roth's name for metamorphic rocks with the composition of gabbros, *i. e.*, rocks not certainly igneous. The name is derived from the Zobtenberg, a Silesian mountain. (Kemp)

Zoic. In geology, containing fossils, or yielding evidence of contemporaneous plant or animal life: said of rocks. (Standard)

Zoisite. A basic orthosilicate of calcium and aluminum, $Ca_2(AlOH)Al_2(SiO_4)_3$; the aluminum is sometimes replaced by iron, thus graduating toward epidote. (Dana)

Zoisitization. The conversion of feldspar into zoisite. (Webster)

Zolotnik. A Russian weight equal to 65.83 grains. (Lock)

Zona (Sp.). 1. A layer or band of mineral in a vein. 2. A zone, belt, or band of rock limited horizontally or vertically, and characterized by certain minerals or fossils. (Halse)

Zonal structure. A term especially used in microscopic work to describe those minerals whose cross-sections show their successive concentric layers of growth. (Kemp)

Zone. 1. In geology, used in the same sense as horizon to indicate a certain geological level or chronological position, without reference to the local attitude or dip of the rock. (Roy. Com.)
2. An area or region more or less set off or characterized as distinct from surrounding parts, as in a metalliferous region, the mineral zone. 3. In crystallography, a series of faces whose intersection lines with each other are all parallel. (Webster)

Zone of capillarity. An area that overlies the zone of saturation and contains capillary voids, some, or all, of which are filled with water that is held above the zone of saturation by molecular attraction acting against gravity. (Meinzer)

Zone of discharge. As suggested by J. W. Finch, the zone embracing that part of the belt of saturation which has a means of horizontal escape. *See* Gathering zone and Static zone. (Lindgren, p. 3)

Zone of flowage. As proposed by Van Hise, the lower zone of the outer part of the earth's crust in which the deformation of rocks is by granulation or recrystallization, no opening being produced, or at least none except of microscopic size. *See* Zone of fracture. (Posepny in Genesis of Ore deposits, p. 286)

Zone of fracture. As proposed by Van Hise, the upper portion of the earth's crust and in which rocks are deformed mainly by fracture. *See* Zone of flowage. (Posepny in Genesis of Ore Deposits, p. 286)

Zone of saturation. An area which contains capillary or supercapillary voids, or both, that are full of water that will move under ordinary hydrostatic pressure. (Meinzer)

Zones. In a shaft furnace, the different portions (horizontal sections) are called zones, and characterized according to the reactions which take place in them, as the zone of fusion or smelting zone, the reduction zone, etc. (Raymond)

Zonochlorite. A zeolitic mineral, perhaps related to thompsonite. (Century)

Zoögene. In geology, of, pertaining to, consisting of, resulting from, or indicative of animal life or structure. (Standard)

Zoölite; Zoölith. A fossil animal. (Webster)

Zorgite. A massive granular selenide of lead and copper in varying amounts. (Dana)

Zueing. *See* Zur.

Zundererz (Ger.). Tinder ore; an ore of antimony occurring in the Saxon mines in soft, flexible, tinderlike masses, of a blackish-red color and little luster. (Page)

Zungite. A fluosilicate of aluminum in transparent tetrahedral crystals, from the Zuni mine, Colorado. (Webster)

Zur; Zueing; Dezuing (Eng.). The same as hulking a lode, *viz*, removing the soft side for facilitating the breaking down the harder part thereof. (Hunt)

Zurlite. A white or green variety of melilite. (Standard)

Zurrón (Mex.). A rawhide ore sack holding about 150 pounds; a load for a *Tanatero*. *See* Tanate. (Dwight)

Zurronero (Mex.). A laborer who conveys ore or waste in bags. (Halse)

Zwieselite. A clove-brown variety of triplite. (Dana)

Zwitter. A Saxon miner's term for a variety of greisen. Only of significance in connection with tin ores. (Kemp)

O

Bulletin 96

DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, SECRETARY
BUREAU OF MINES
VAN. H. MANNING, DIRECTOR

THE ANALYSIS OF PERMISSIBLE EXPLOSIVES

BY

C. G. STORM

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THE ANALYSIS OF PERMISSIBLE EXPLOSIVES.

By C. G. Storm.

INTRODUCTION.

Permissible explosives are those that have passed the tests prescribed by the Bureau of Mines for explosives intended for use in coal mines, and are therefore recommended by the bureau as suitable for this class of work when used under the prescribed conditions. The tests for permissible explosives and the conditions prescribed for their use are described in Miners' Circular 6 of the Bureau of Mines.[a] Up to June 1, 1915, 168 explosives had been classed as permissible explosives; 133 of them were then on the bureau's "permissible list" and 35 had been withdrawn by the manufacturers.

In addition to the required physical tests, each explosive is subjected to a complete chemical examination in order that its exact composition may be known and also that the composition of future samples of the same explosive collected in the field may be compared with that of the sample which originally passed the bureau's tests, for by such comparison it may be possible to ascertain whether or not the explosive as supplied to the miner is still "permissible."

This bulletin is published primarily for the purpose of informing manufacturers of such explosives as to the methods used by the Bureau of Mines in the analysis of samples received for tests to determine their permissibility. Such information may be of value in cases of possible controversy over the results obtained in the analysis of a field sample as compared with those obtained in analyzing the sample originally tested by the bureau. Also, a description of the methods used by the Bureau of Mines in the analysis of explosives should be of assistance to the many chemists engaged in similar analytical work.

ACKNOWLEDGMENTS.

The writer desires to acknowledge the valuable assistance of A. L. Hyde, W. C. Cope, J. H. Hunter, J. E. Crawshaw, and C. A. Taylor, of the explosives chemical laboratory of the Bureau of Mines, in obtaining the analytical results included in this bulletin.

[a] Hall, Clarence, Permissible explosives tested prior to Jan. 1, 1912, and precautions to be observed in their use: Miners' Circular 6, Bureau of Mines, 1912, 20 pp.

NATURE OF PERMISSIBLE EXPLOSIVES.

In explosives intended for use in open work, such as quarrying, the factor of prime importance is efficiency in bringing down the material to be blasted. Such explosives are therefore so constituted as to produce the desired effects without regard to the temperature of explosion, the amount of flame produced, or the nature of the gaseous products. The properties essential to explosives used in tunneling are efficiency and the absence of poisonous gases in the products of explosion. Coal-mining explosives should possess not only all of these qualities but should evolve on explosion flames of relatively low temperature.

By proper changes in its composition or in the properties of its components, an explosive of any type may be altered so that on explosion it will not ignite an explosive mixture of coal gas or coal dust or both with air.

The general methods in use at the present time for bringing about a reduction in the flame temperature of explosive mixtures have been discussed in another publication of the Bureau of Mines,[a] and are summarized as follows:

(*a*) The addition of an excess of carbon, for the purpose of reducing the amount of carbon dioxide formed.
(*b*) The addition of free water.
(*c*) The addition of solids holding water of crystallization.
(*d*) The addition of inert materials.
(*e*) The addition of volatile salts.

The effects of such additions have been considered from the viewpoint of thermochemistry in the publication referred to. This bulletin discusses the variations in the methods of chemical analysis made necessary by such alterations in the composition of the ordinary types of blasting explosives.

CLASSIFICATION OF PERMISSIBLE EXPLOSIVES.

Permissible explosives have been classified, according to their characteristic components, into four general classes[b] as follows:

Class 1—Ammonium-nitrate explosives.
Class 2—Hydrated explosives.
Class 3—Organic nitrate (other than nitroglycerin) explosives.
Class 4—Nitroglycerin explosives.

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[a] Hall, Clarence, Snelling, W. O., and Howell, S. P., Investigations of explosives used in coal mines, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by C. E. Munroe: Bull. 15, Bureau of Mines, 1912, pp. 51–58.

[b] Hall, Clarence, Permissible explosives tested prior to Jan. 1, 1912, and precautions to be taken in their use: Miners' Circular 6, Bureau of Mines, 1912, pp. 12–14; Permissible explosives tested prior to Jan. 1, 1914: Tech. Paper 71, Bureau of Mines, 1914, pp. 8–10.

Of the 168 explosives which passed the bureau's tests for permissibility up to June 1, 1915, 75 were explosives of class 1, 9 were of class 2, 9 were of class 3, and 75 were of class 4. Of the 35 of these which have been withdrawn from the list 14 were of class 1, 3 of class 2, 6 of class 3, and 12 of class 4.

Although, up to June 1, 1915, no explosives containing chlorates or perchlorates as their characteristic ingredients have been placed upon the bureau's permissible list, a number of such explosives have been tested by the bureau. The chlorate or perchlorate explosives form an additional class to the four classes enumerated above, but because they are presented for testing, methods for their analysis are discussed herein.

GENERAL CHARACTERISTICS OF PERMISSIBLE EXPLOSIVES.

AMMONIUM NITRATE EXPLOSIVES.

Ammonium nitrate, although not commonly regarded as an explosive substance, has been shown to be capable of explosive decomposition. Berthelot[a] gives seven different decomposition reactions of ammonium nitrate, three of which are explosive in their nature. The maximum effect is produced by the reaction—

$$2NH_4NO_3=4H_2O+O_2+2N_2,$$

which results under the influence of sudden high temperature and pressure, as by the action of a strong detonator. The effect of weaker detonators is to produce other forms of decomposition, yielding oxides of nitrogen.

Lobry de Bruyn[b] succeeded in detonating a charge of 180 grams of pure ammonium nitrate compressed in an 8-cm. shell, using a priming charge of 20 to 30 grams of Bellite (a mixture of ammonium nitrate and dinitrobenzene), and a detonator containing 1 gram of mercury fulminate. The shell was disrupted into many fragments. Without the priming charge of Bellite, a detonator containing 3 grams of mercury fulminate produced only incomplete explosion of the ammonium nitrate.

Lheure[c] obtained complete detonation of cartridges of pure ammonium nitrate loaded in drill holes in rock, using a detonating fuse (cordeau detonant) of trinitrotoluene as the initial detonator, the fuse passing completely through the cartridge.

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[a] Berthelot, M., Sur la force des matières explosives, t. 2, 1883, p. 183.

[b] Lobry de Bruyn, C. A., Sur l'explosivité de l'azotate d'ammonium: Rec. trav. chim. Pays-Bas, t. 10, 1891, pp. 127–131; Escales, R., Die Explosivstoffe, Bd. 4, 1909, p. 40.

[c] Lheure, —, Note sur l'amélioration de la sécurité dans les mines grisouteuses par emploi d'un nouveau dispositif d'amorcage des explosifs: Ann. des mines, sér. 10, t. 12, 1907, p. 169; Escales, R., Die Explosivstoffe, Bd. 4, 1909, p. 130.

The temperature of explosion, as calculated from the above reaction, is only 1,121° C.,[a] much lower than the calculated temperatures resulting from the usual types of permissible coal-mining explosives, which generally vary between 1,500° and 2,000° C. Its insensitiveness and relatively low explosion pressure, however, prevent pure ammonium nitrate per se from having any practical application as a blasting explosive.

By the admixture of suitable combustible materials, this insensitiveness is overcome and explosives of greater strength are obtained. As has been noted, a large proportion of the explosives which have been placed on the bureau's permissible list are of this type, the list on June 1, 1915, including 61 ammonium-nitrate explosives out of a total of 133 explosives; 14 other ammonium-nitrate explosives formerly on the permissible list have been withdrawn.

The materials used as sensitizers for ammonium nitrate may be (1) explosive or (2) nonexplosive. The first group of sensitizers comprises nitroglycerin, nitrocellulose, nitrosubstitution compounds, or mixtures of two or more of these substances. The second group includes various nonexplosive combustible materials, such as resins, sulphur, carbonized curcuma powder, cereal flour, sugar, hydrocarbon oils or other oils, paraffin, and coal.

HYDRATED EXPLOSIVES.

Under the designation "hydrated explosives" are included those that depend for reduction of their flame temperature largely upon the cooling effect of water in the form of water of crystallization of certain salts included in their composition.

The list of "permissible explosives" included, on June 1, 1915, 6 explosives under this classification and 3 others previously in this class had been withdrawn.

The hydrated salts used in these explosives are Epsom salt ($MgSO_4.7H_2O$), or potassium alum [$K_2Al_2(SO_4)_4.24H_2O$], containing respectively 51.22 per cent and 45.57 per cent water of crystallization.

Certain explosives included in other classes of "permissible explosives" also contain these hydrated salts, as well as aluminum sulphate [$Al_2(SO_4)_3.18H_2O$], with 48.81 per cent of water or gypsum ($CaSO_4.2H_2O$), with 20.92 per cent of water, but not in sufficient quantities to justify their classification as hydrated explosives.

[a] Hall, Clarence, Snelling, W. O., and Howell, S. P., Investigations of explosives used in coal mines, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by C. E. Munroe: Bull. 15, Bureau of Mines, 1912, p. 32. Other calculated values for the temperature of explosion of ammonium nitrate are 1,134° C. (Heise) and 1,130° C. (French Explosives Commission), given by Escales, R., Die Explosivstoffe, Bd. 4, 1909, p. 47.

The hydrated explosives all contain nitroglycerin as the principal explosive ingredient, and most of them also contain ammonium nitrate and various other components common to explosives of other classes.

ORGANIC NITRATE (OTHER THAN NITROGLYCERIN) EXPLOSIVES.

The "permissible list" on June 1, 1915, included only 3 explosives of this class; 6 others had previously been withdrawn from the list.

This class includes explosives containing nitrostarch[a] or other organic nitrate as their characteristic ingredient.

Nitrostarch, without the admixture of other ingredients which reduce its brisance and high explosion temperature, and modify other of its properties, is unsuited for use as a coal-mining explosive. The temperature of explosion of nitrostarch containing 12.75 per cent nitrogen is, as calculated by the writer, approximately 2,340° C., which is considerably higher than the explosion temperatures of permissible explosives.[b] Furthermore, the products of explosion of nitrostarch include larger amounts of carbon monoxide than are desirable in mining explosives. By suitable additions of oxidizing agents and heat-absorbing materials, it is possible, however, to prepare nitrostarch explosives answering all requirements of permissible explosives.

NITROGLYCERIN EXPLOSIVES.

The classification "nitroglycerin explosives" includes those explosives whose characteristic ingredient is nitroglycerin which are not included in the class of "hydrated explosives."

Of the 133 explosives on the "permissible list," June 1, 1915, 63 were included in this class, and 12 others previously in this class had been withdrawn from the list before that date.

The ingredients used in explosives of this class include practically all those entering into the composition of explosives of the various other classes.

Permissible explosives of the nitroglycerin class may be regarded as modified dynamites, in which any of the general methods mentioned on page 6, or combinations of these methods, may be employed for reducing the amount and temperature of the flame produced by explosion.

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[a] The term "nitrostarch" is used in this bulletin because of its acceptance in general usage. The correct chemical designation is starch nitrate.

[b] See Hall, Clarence, Snelling, W. O., and Howell, S. P., Investigations of explosives used in coal mines, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by C. E. Munroe: Bull. 15, Bureau of Mines, 1912, p. 28.

PHYSICAL EXAMINATION OF PERMISSIBLE EXPLOSIVES.

Among the requirements which must be met by an explosive in order that it may be classed as a "permissible explosive" are found the following:[a]

"An explosive will be considered unsatisfactory if it is not chemically stable, if it shows leakage of nitroglycerin, or if it is in such condition that exudation of nitroglycerin would occur in handling or transportation."

It is therefore important that tests be made on each sample of explosive to determine its stability and liability to exude nitroglycerin. In addition to these tests the determination of gravimetric density is included as part of the physical examination.

DETERMINATION OF GRAVIMETRIC DENSITY.

The determination of gravimetric density or apparent specific gravity of the cartridge of explosive has been already described in a former publication.[b] The volume of the entire cartridge is found by determining the amount of uniform sand, of previously determined gravimetric density, displaced by the cartridge. The weight of the cartridge in grams divided by its volume in cubic centimeters gives the apparent specific gravity or gravimetric density of the cartridge.

TESTS FOR LIABILITY OF EXUDATION.

The three general methods for determining the liability of exudation of liquid ingredients from cartridges of an explosive have been described for the ordinary types of dynamites.[c] These methods are employed in the same manner for "permissible explosives." The method generally employed in the bureau's laboratory is the centrifugal method, in which 8-gram samples of the explosive, each contained in an ordinary porcelain Gooch crucible without a mat, are centrifuged for 5 minutes at a speed of 600 revolutions per minute, the circle of rotation made by the bottom of the crucibles being 28 centimeters in diameter. Any exuding nitroglycerin is absorbed in a small quantity of cotton placed in an ordinary porcelain crucible suspended beneath the Gooch crucible.

The temperature at which the test is made should be approximately 20° C. Under these conditions a loss of more than 5 per cent of the original weight of the sample is considered by the bureau to indi-

[a] Fees for testing explosives, Bureau of Mines, Schedule 1, Sept. 17, 1913, 8 pp.

[b] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite, Bull. 51, Bureau of Mines, 1913, pp. 7–8.

[c] Snelling, W. O., and Storm, C. G., Op. cit., pp. 8–10.

cate liability of leakage of nitroglycerin from the cartridges in transportation or storage.

It should be noted, however, that exudation is much less liable to occur in explosives of the "permissible" type than in ordinary grades of dynamite because of the smaller content of nitroglycerin in most explosives of the former class.

TESTS FOR STABILITY.

ABEL TEST.

All samples of explosives submitted to the bureau are tested by the Abel heat test, a full description of which has been published by the bureau.[a] Briefly, the test depends upon the time required for the production of a brownish line of discoloration of standard intensity on a strip of potassium iodide-starch paper suspended above the explosive in a glass test tube by the oxides of nitrogen liberated from the explosive when the sample is heated in a water bath at a constant temperature. The test is made in duplicate, on samples weighing 2 grams each, at a temperature of 71° C. ±0.5° C. An explosive is considered to be of unsatisfactory stability when the time of the test is less than 10 minutes.

"INTERNATIONAL" 75° TEST.

The "preliminary test" recommended by the international commission which reported to the Eighth International Congress of Applied Chemistry, 1912, on "Methods for Testing the Stability of Explosives,"[b] is made use of to supplement the Abel test. This test is made as follows:

METHOD OF MAKING THE TEST.

Two samples of explosive of 10 grams each, without previous drying, are placed in glass tubes 35 mm. in diameter and 50 mm. in height; the tubes are loosely covered with watch glasses and heated for 48 hours in a constant-temperature oven at 75° C.

At the end of this period of heating the samples are examined for signs of decomposition, as indicated by change of appearance or by odor or the presence of nitrous fumes in the tube. The explosive is considered to be of unsatisfactory stability if positive indication of decomposition is noted.

In order to gain additional information as to the behavior of explosives under the conditions of this test, in tests by the bureau the

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite, Bull. 51, Bureau of Mines, 1913, pp. 10–12.

[b] Commision Internationale pour L'Etude de L'Unification des Methodes D'Épreuves sur la Stabilite des Explosifs; Rapport, final apprové le 25 juillet 1912, pour être présenté au VIIIme Congrès International: Original Communications, Eighth Int. Cong. App. Chem., vol. 25, September, 1912, p. 261.

tubes containing the samples have been accurately weighed before and after heating at 75° C. and the loss of weight noted in terms of percentage of the weight of original sample. Any marked decomposition of the explosive or of any of its components would be indicated by a considerable loss of weight in excess of the moisture content of the explosive, due consideration being made for the fact that some loss from volatilization of nitroglycerin, or possibly of other constituents, will result during such heating.

COMPARISON OF RESULTS OF "ABEL" AND "INTERNATIONAL" TESTS.

As a general rule, the loss of weight noted in testing stable explosives by this method is but a small amount in excess of the moisture content, the difference being usually less than 0.5 per cent and rarely exceeding 1 per cent. One explosive of doubtful stability, which contained among other ingredients nitroglycerin, potassium chlorate, and ammonium nitrate (a very unusual and dangerous mixture), gave an Abel test of only 7 to 9 minutes, and on being subjected to the "international" 75° test it evolved odors of chlorine and oxides of nitrogen and lost nearly 5 per cent in weight in excess of the moisture content.

A large number of tests made by the "international" method in the bureau's laboratory have substantiated the results of the Abel test.

SAMPLING AND PREPARATION FOR ANALYSIS.

The test requirements provide that samples of 100 pounds of each explosive to be tested for permissibility must be submitted to the bureau by the manufacturer. From this large sample, 4 to 6 cartridges are selected at random for chemical examination. A sample for analysis is prepared by removing the paper wrapper, care being taken that particles of paraffin from the outside of the wrapper do not become mixed with the explosive, cutting off with a horn spatula 3 to 5 cm. of each end of the cartridge and mixing thoroughly the central parts of each cartridge in a porcelain dish with a large horn spoon. The explosive is reduced to a mass of such uniformity as the fineness of the ingredients will permit, all hard masses of particles being broken up by means of the spoon. After very thorough mixing of the sample, a wide-mouthed sample bottle of about 250 c. c. capacity is filled by taking portions with the spoon from different parts of the entire mass in the dish. The sample in the bottle should be remixed immediately before analysis in order to compensate for any segregation of liquid ingredients. Experiments have demonstrated that appreciable segregation may occur in even a few days.[a]

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite, Bull. 51, Bureau of Mines, 1913, pp. 14–15.

QUALITATIVE ANALYSIS.

In order to decide upon the method of quantitative analysis to be followed, it is essential that first a complete qualitative analysis of the explosive should be made. After such examination has shown the identity of the components of the explosive mixture, the proper methods for quantitative separation or determination of these components can then be chosen.

The general methods for the qualitative analysis of permissible explosives are the same as those described in Bulletin 51[a] for ordinary types of dynamite. It should be noted, however, that many substances are employed as constituents of the low-flame explosives which are not found in ordinary blasting explosives.

COMPONENTS OF LOW-FLAME EXPLOSIVES.

Below is given a list of some of the substances which have been found in low-flame explosives. Most of them have been identified as constituents of explosives manufactured in this country; a few are ingredients of foreign explosives.

These substances are classified according to their solubility in the general scheme usually followed in analysis.

Some components of low-flame explosives.

Soluble in ether.	Soluble in water.	
Asphaltum.	Alum (crystals).	Sodium sulphate.
Nitrobenzenes.	Aluminum sulphate (crystals).	Sugar.
Nitroglycerin.	Ammonium chloride.	Zinc oxide.[b]
Nitronaphthalenes.	Ammonium nitrate.	**Insoluble.**
Nitropolyglycerin.	Ammonium oxalate.	Charcoal.
Nitrotoluenes.	Ammonium perchlorate.	Clay.
Oils (mineral or vegetable).	Ammonium sulphate.	Coal.
Paraffin.	Barium nitrate.	Corn meal.
Resins.	Calcium sulphate (crystals).	Corncob meal.
Sulphur.	Gums.	Graphite.
Vaseline.	Magnesium sulphate (crystals).	Kieselguhr.
Soluble in acid.	Potassium bichromate.	Nitrated wood.
Aluminum.	Potassium chlorate.	Nitrocellulose.
Calcium carbonate.	Potassium nitrate.	Nitrostarch.
Calcium silicide.	Potassium perchlorate.	Peanut-shell meal.
Ferric oxide.[c]	Potassium sulphate.	Powdered slate.
Magnesium carbonate.	Sodium bicarbonate.	Rice hulls.
Manganese dioxide.[c]	Sodium carbonate.	Sand.
Zinc.	Sodium chloride.	Sawdust.
Zinc oxide.[b]	Sodium nitrate.	Turmeric.
		Vegetable ivory meal.
		Wheat flour.
		Wood pulp.

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite, Bull. 51; Bureau of Mines, 1913, pp. 16–19.

[b] Generally found partly or wholly in the water extract owing to its solubility in ammonium-nitrate solutions.

[c] Partly soluble in the dilute acid used.

METHOD OF CONDUCTING QUALITATIVE ANALYSIS.

In conducting the qualitative examination of a permissible explosive it is usually advisable to separate its components into groups, as indicated above, by successive extractions with ether, water, and dilute hydrochloric acid (1:10), so that the identification of the various ingredients present is much simplified.

These extractions are conveniently made by shaking a rather large sample (about 25 grams) of the explosive with ether in a large stoppered test tube, filtering the solution through a paper filter and treating the residue once or twice again with fresh ether in the same manner. The ether solution is evaporated, and the insoluble residue, after drying to remove adhering ether, is treated in a similar manner with water, and finally with dilute hydrochloric acid.

SPECIAL QUALITATIVE TESTS.

Tests for some of the more unusual substances, not generally found in the ordinary types of blasting explosives, are made as follows:

TEST FOR NITROPOLYGLYCERIN.

In making a test for nitropolyglycerin the ether extract, after evaporation of the ether, is filtered through a paper filter in order to separate any insoluble oily or resinous materials. Some of the clear filtrate is tested for nitrosubstitution compounds by means of the color test described in Bulletin 51.[a] In the absence of nitrosubstitution compounds the filtrate is tested for nitropolyglycerin by determining its solubility in a mixture of 60 parts glacial acetic acid and 40 parts water, as described on page 53. This test readily detects nitropolyglycerin in admixture with nitroglycerin.

TEST FOR MONONITRONAPHTHALENE.

Mononitronaphthalene is readily detected in the residue obtained by evaporation of the ether extract by adding a drop of this material to a mixture of about equal parts of strong sulphuric acid and water. Mononitronaphthalene, if present, causes a brilliant red color.

TEST FOR CHLORIDES, CHLORATES, AND PERCHLORATES.

Chlorides, chlorates, and perchlorates in a mixture are identified as follows: Some of the solution in water is acidified with a few drops of nitric acid, an excess of silver nitrate added, the mixture heated to boiling, shaken well to coagulate the precipitate of silver chloride, and filtered. To the clear filtrate a few cubic centimeters of formaldehyde (40 per cent solution) is added and the mixture is then boiled.

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite, Bull. 51, Bureau of Mines, 1913, pp. 17-18.

The formaldehyde reduces any chlorate present to chloride, which is precipitated as silver chloride by the excess of silver nitrate present. The reaction is practically complete if the mixture is allowed to stand on the steam bath for about an hour, although a considerably longer time is required for quantitative reduction.

The precipitate is filtered off and the filtrate evaporated to dryness to remove excess of nitric acid, transferred with a small volume of water to a crucible, enough dry sodium carbonate added to fill the crucible, the mixture dried carefully over a burner, and fused. The fused mass is dissolved in dilute nitric acid. If perchlorates are present, the solution will be found to contain a precipitate of silver chloride.

TEST FOR SUGAR.

The presence of any appreciable quantity of organic substances in the solution in water is indicated by a more than slight charring of the residue, obtained by evaporating the solution, when it is heated over a burner. Sugar is tested for by acidifying some of the water solution with a little dilute hydrochloric acid, heating to boiling in order that any cane sugar present may be inverted, neutralizing with potassium hydroxide, and boiling with Fehling's solution. A precipitation of reduced cuprous oxide indicates the presence of sugar.

TEST FOR GUM ARABIC.

Gum arabic is precipitated by the addition of a solution of basic lead acetate to the water extract. (See quantitative determination of gum arabic, p. 67.)

TEST FOR NITROSTARCH.

Nitrostarch in the residue left after extracting the water-soluble ingredients is detected by examining a small portion of the residue under the microscope. (See p. 74.) Nitrostarch is readily distinguished from unnitrated starch by moistening the residue under the microscope with a drop of solution of iodine in potassium iodide; the unnitrated starch granules are colored dark blue by the iodine solution, whereas nitrostarch granules are not affected.

TEST FOR NITROCELLULOSE.

Nitrocellulose is readily distinguished from nitrostarch by means of the microscope, but when present in small amounts may be overlooked. The dried residue insoluble in water should be treated with acetone and the acetone extract poured into hot water in order to volatilize the acetone and precipitate any dissolved nitrocellulose. The white precipitate may be dried and identified as nitrocellulose or nitrostarch by its rapid burning on being ignited with a flame. Of

course, this last test will not distinguish between nitrocellulose and nitrostarch.

IDENTIFICATION OF WOOD PULP MIXED WITH CEREAL PRODUCTS.

The following test devised by Le Roy[a] has been found valuable for the identification of small amounts of wood pulp mixed with various cereal products.

One gram of phloroglucinol is dissolved in 15 c. c. of ethyl alcohol (90 to 95 per cent) and 10 c. c. of sirupy phosphoric acid is added. Then 0.5 c. c. of this reagent is rubbed with a little of the sample in a porcelain dish. The wood fibers quickly become colored a rose tint, gradually turning to carmine.

This test was tried by the author on coarse and fine wheat flour and on corn meal with negative results. A very small proportion of wood pulp mixed with these cereals was indicated by red spots throughout the mixture. Examination under the microscope showed that each fiber of the wood pulp was colored a bright carmine, whereas the starch granules and cereal fibers were unchanged in color.

Less than 0.5 per cent of wood pulp in an explosive containing 36 per cent of corn meal was readily detected. Such amounts of wood pulp may enter into the composition of an explosive from imperfect cleaning of the mixing bowl after a previous mixing.

IDENTIFICATION OF WHEAT FLOUR AND CORN MEAL.

The following tests[b] have been found of assistance in distinguishing between finely ground white corn meal and coarse wheat flour:

GLYCERIN TEST.

About 1 gram of the material is treated with 15 c. c. of glycerin and boiled for a few minutes. Corn is indicated by the well-known pop-corn odor.

This test was tried separately on both corn meal and wheat middlings. At first the difference in odor was hardly appreciable, but after a few minutes of boiling the wheat darkened to a brown color and gave an unpleasant "burnt" odor, whereas the corn meal continued to evolve the pleasant odor of pop corn.

ALKALI TEST.

A small quantity of the material is treated with 10 c. c. of a 1.8 per cent solution of potassium hydroxide and allowed to stand for about two minutes in a test tube; it is then made nearly neutral with

[a] Le Roy, G. A., Recherche de la sciure (fleurage) de bois dans les farines: Ann. chim. anal., t. 4, 1899, p. 221; Allen, A. H., Commercial organic analysis, vol. 1, 1905, p. 462.

[b] Allen, A. H., Loc. cit.

dilute hydrochloric acid. The formation of a stiff, gelatinous mass indicates wheat starch, whereas cornstarch is not altered.

This test and the glycerin test are of use mainly when the residue left after extraction with water contains no ingredients other than wheat flour or corn meal.

MECHANICAL SEPARATION OF SOLID INGREDIENTS.

It is frequently difficult, in analyzing a permissible explosive that contains a number of water-soluble ingredients, to ascertain definitely the manner in which the various acid and basic ions, found in the water extract by qualitative tests and quantitatively determined by gravimetric or volumetric methods, were combined in the original explosive. The difficulties are similar to those encountered in reporting the results of water analyses. The water analyst usually solves the difficulty by reporting the positive and negative ions separately without attempting to determine their actual combinations. It is necessary, however, that the report of the analysis of a permissible explosive should give definite information as to the various salts present.

As an instance of such mixtures, a solution giving tests for Na, NH_4, Cl, and No_3, may be examined quantitatively and the amount of each of these ions present accurately determined, without definite knowledge being obtained as to whether the salts contained in the water solution were (*a*) $NaNO_3$, NH_4NO_3, NaCl and NH_4Cl, or (*b*) $NaNO_3$ and NH_4Cl, or (*c*) NH_4NO_3 and NaCl.

Although chemical analysis of such a water extract offers no means of determining its true composition, the writer has found that it is often possible to gain considerable information by a mechanical separation of the original solid ingredients before dissolving in water. Such mechanical separation is facilitated by the fact that the ingredients of explosives are frequently not finely pulverized in the course of manufacture.

SEPARATION OF INGREDIENTS BY SCREENING.

The separation is carried out as follows:

A sample of 25 to 50 grams of the original explosive is washed several times with ether in order to remove the nitroglycerin, oily materials, or other ether-soluble substances; the residue is dried a short time until the adhering ether has evaporated, and then sifted through a set of sieves. The coarser sieves (10 and 20 mesh) will usually be found to retain more or less material consisting of coarse fragments of wood pulp or other carbonaceous absorbent, together with coarse crystals of the water-soluble ingredients that have escaped pulverization or have purposely been incorporated in a coarse

condition. This coarse material is spread out on a piece of glazed paper and crystals of similar appearance sorted out by the aid of a pair of forceps. A few fragments or crystals of each kind may be separately tested qualitatively and readily identified. Much information can often be gained by dissolving a single crystal in a drop of water on a microscope slide, allowing the water to evaporate, and examining the resulting crystals under the microscope, with or without the polarizing attachment. Many substances are easily identified in this manner. A single crystal may be dissolved in 1 or 2 c. c. of water, the solution divided into several small parts, and separate tests made on each part, a process which may serve absolutely to identify the crystal.

Among many instances in which mechanical separation has been useful are the following:

1. An explosive contained, among other ingredients, ammonium nitrate, ammonium sulphate, crystallized potassium alum, potassium sulphate, and coal. By sifting and picking over the coarser crystals, coal, alum, ammonium nitrate, and ammonium sulphate were separated and positively identified.

2. From another explosive, sodium nitrate, ammonium nitrate, crystallized magnesium sulphate, and corn meal were separated and identified.

3. From a third explosive, crystalline trinitrotoluene, alum, and ammonium nitrate were isolated.

In each of these instances the identification of these constituents enabled the actual composition of the mixtures to be calculated from the results of the quantitative analysis without "guesswork" as to the manner in which the various bases and radicles were combined.

SPECIFIC-GRAVITY SEPARATION OF INGREDIENTS.

Another method, which is much used in the bureau's laboratory, for the identification of the various components of such mixtures as those mentioned depends on the fact that the different components differ in specific gravity. This method, which has been described in Technical Paper 78[a] of the bureau, is briefly summarized here. The separation is effected in a mixture of bromoform (specific gravity 2.83) and chloroform (specific gravity 1.49). These liquids are miscible in all proportions, and yield liquid mixtures of any desired density between the limits of their respective specific gravities. The various salts used in blasting explosives are insoluble in such mixtures, and the specific gravities of these salts lie mostly between 1.50 and 2.50, a range which is entirely covered by the possible bromoform-chloroform mixtures.

[a] Storm, C. G., and Hyde, A. L., Specific-gravity separation applied to the analysis of mining explosives: Tech. Paper 78, Bureau of Mines, 1914, 14 pp.

A series of these liquid mixtures is prepared, with specific gravities of 1.60, 1.77, 1.89, 1.98, 2.16, etc., respectively. The specific gravities mentioned have been found especially useful, but obviously any desired mixture within the limits mentioned may be prepared. These mixtures can be used repeatedly, being filtered back into the original bottles after use. Their specific gravities should be checked from time to time.

A sample of the original explosive to be tested is extracted several times with ether to remove all liquid ingredients, dried thoroughly in an oven, and then some of the dry material is shaken with a quantity of one of the bromoform-chloroform mixtures in a small separatory funnel provided with a wide-bore stopcock. On standing a short time, the mixture being carefully stirred meanwhile with a thin glass rod so as to liberate any entangled air bubbles, the solid substances separate into two layers, the heavier crystals settling to the bottom and the lighter crystals and carbonaceous material collecting as a layer in the upper part of the liquid.

The heavier salt may be drawn off into a dish or beaker by quickly opening the cock and again closing it before the lighter solids begin to come through. The greater part of the liquid drawn off is decanted back into the funnel, and the heavy crystals dried and examined by means of qualitative tests.

It may also be found possible to separate a part of the lighter salt from the carbonaceous material by further treatment in a similar manner with a liquid of less density than the one first used.

The specific gravities of some of the more common salts that may be present are as follows:[a]

Specific gravities of salts occurring in explosives.

Salt.	Specific gravity.	Temperature.	Authority.
		°C.	
Ammonium alum (crystals)	1.62		Clarke, F. W.
Ammonium chloride	1.52		Schröder.
Ammonium nitrate	1.74		Do.
Ammonium perchlorate	1.87		Woulf.
Ammonium sulphate	1.77	20	Retgers.
Barium nitrate	3.23		Clarke, F. W.
Calcium carbonate (precipitated)	2.72		Rose, G.
Calcium sulphate (anhydrous)	2.97		Schröder.
Calcium sulphate+$2H_2O$	2.32		Clarke, F. W.
Magnesium carbonate	3.04		Schröder.
Magnesium sulphate+$7H_2O$	1.68		Clarke, F. W.
Magnesium sulphate (anhydrous)	2.65		Do.
Manganese dioxide	5.03		Retgers.
Potassium alum (crystals)	1.75	17	Do.
Potassium chlorate	2.33		Clarke, F. W.
Potassium chloride	1.99	16	Retgers.
Potassium nitrate	2.09		Clarke, F. W.
Potassium perchlorate	2.52		Schröder.
Potassium sulphate	2.66	20	Tutton.
Sodium chloride	2.17	17	Retgers.
Sodium nitrate	2.26		Clarke, F. W.
Sodium sulphate (anhydrous)	2.66		Do.
Sodium sulphate+$10H_2O$	1.46		Do.

[a] Landolt and Börnstein, Physikalisch-chemische Tabellen, pp. 230–251.

It is necessary that the specific gravity of the liquid mixture used should be at least about 0.1 less than that of the salt which it is desired to separate from lighter ingredients. The separation is never complete because of the buoyant effect of air bubbles and of particles of wood pulp or other carbonaceous materials, which adhere to the heavier crystals.

EXAMPLE OF USEFULNESS OF METHOD.

The following is an example of the usefulness of the method of specific-gravity separation as applied to an ordinary type of permissible explosive: The solution from treatment of the explosive with water was found by the usual qualitative tests to contain NH_4, Na, NO_3, and Cl. Qualitative and quantitative determinations failed to show the manner in which the acid and basic radicles were combined, that is, whether the salts present were $NaNO_3$ and NH_4Cl, NaCl, and NH_4NO_3, or a mixture of all four of these substances. On applying the specific-gravity method, using a liquid mixture of 1.8 specific gravity, crystals of $NaNO_3$ sank to the bottom, were drawn off, and identified. NaCl, if present, would have been found with the $NaNO_3$, but no test for Cl was obtained. The lighter portion of the salts gave strong qualitative tests for NH_4, Cl, and NO_3. It was therefore established that the explosive contained a mixture of $NaNO_3$, NH_4NO_3, and NH_4Cl.

MICROSCOPIC EXAMINATION.

The use of the microscope in identifying constituents of the insoluble residue is discussed on page 74.

Much information is frequently obtained as to the identity of the constituents of an explosive by examining a sample of the original explosive under relatively low magnification by the aid of the binocular microscope. In some explosives it is possible to identify as many as four or five constituents by a rapid examination under the microscope. Familiarity with the form and appearance of the various crystalline and noncrystalline substances used in explosives is, of course, essential, and such familiarity can best be obtained by a study, under the microscope, of samples of these different substances.

Single fragments of crystals may be dissolved in a drop of water and the solution allowed to evaporate slowly on a microscope slide, in order to obtain perfectly formed crystals of the substance to be identified.

QUANTITATIVE ANALYSIS.

It has been shown in the discussion of the general characteristics of permissible explosives of the different classes (pp. 7 to 10) that most of the ingredients used in the explosives of any class may be found in the explosives of any other class. A separate discussion of the methods of analysis used for explosives of each class would therefore involve much useless repetition. In general, the analysis of any permissible explosive is carried out by successive extractions of a suitable sample of the explosive with different solvents, usually ether, water, dilute hydrochloric acid, or other liquids which act as solvents only, each of the solutions obtained being designed to contain one or more unchanged components of the explosive. The components thus separated from the mixture are then analyzed to determine the proportion of each in the explosive.

The general method of procedure is therefore quite similar to that employed in the analysis of the ordinary types of dynamite, described in Bulletin 51,[a] although the introduction of components not found in ordinary dynamites increases the difficulties of analyzing explosives of the permissible type.

DETERMINATION OF MOISTURE.

The amount of moisture in ammonium-nitrate explosives is usually small. Obviously, water is never intentionally added to explosives of this type for the purpose of reducing the temperature of explosion. Because of the hygroscopic nature of ammonium nitrate, and the fact that its insensitiveness is increased by the absorption of moisture, all ingredients of explosives containing ammonium nitrate are generally well dried. About 75 per cent of the explosives of this type tested by the bureau have contained less than 1 per cent of moisture.

The moisture content of the nitroglycerin explosives may be rather high, as the addition of water is one of the means frequently employed for reducing the flame temperature of such explosives. The moisture content of some of the permissible explosives of this type is as high as 10 per cent.

The determination of moisture in permissible explosives of all classes is made by the method described in Bulletin 51.[b] A sample weighing approximately 2 grams is spread evenly over the surface of a 2-inch watch glass and desiccated over sulphuric acid for three days at a room temperature as near 20° C. as possible. The loss of weight is considered as moisture.

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, pp. 16–50.

[b] Snelling, W. O., and Storm, C. G., op. cit., p. 29.

FACTORS AFFECTING RESULTS OF MOISTURE DETERMINATION.

The extent to which these results are affected by variations in temperature, weight of sample, exposed surface of sample, quantity and strength of acid, type of desiccator, and other conditions have been considered in Bulletin 51.[a]

The accuracy of the results obtained in determining moisture by desiccation also depends on the absence of any other ingredients from the explosive that could be lost during desiccation.

The principal ingredients whose volatility may influence the results are nitroglycerin, some of the nitrosubstitution compounds, and combined water in substances containing water of crystallization.

EFFECT OF VOLATILITY OF NITROGLYCERIN.

It has been demonstrated by experiments described in Bulletin 51[b] that there is a continual loss of nitroglycerin from explosives containing this ingredient, during the determination of moisture by desiccation; that this loss varies with the temperature; and that it is impossible to bring such a sample to constant weight under ordinary conditions of determination.

It is believed, however, that in desiccation for three days under the conditions above described the amount of nitroglycerin volatilized is inappreciable.

ILLUSTRATIVE EXPERIMENT.

To illustrate the fact that nitroglycerin is appreciably volatile at ordinary temperatures and that its volatility increases with the temperature, an experiment was described in Bulletin 51[c] in which 2 grams of a "60 per cent" dynamite was spread on a 3-inch watch glass, dried over sulphuric acid for three days to remove moisture, and then placed in an empty desiccator containing no drying agent, the desiccator being placed in an incubator oven at a constant temperature of 33° to 35° C. The sample was weighed at intervals and the loss of weight noted. The results are shown by the curve in figure 1.

Since the publication of the bulletin mentioned additional weighings of the sample have been made, covering a total period of 459 days. After the last weight was taken the sample on the watch glass was analyzed in order to determine whether the total loss of weight could be accounted for by the actual loss of nitroglycerin as determined by analysis.

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[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, pp. 19–27.

[b] Snelling, W. O., and Storm, C. G., op. cit., pp. 24–26.

[c] Snelling, W. O., and Storm, C. G., op cit., pp. 26, 27.

The entire data of the experiment are shown in the following table:

Effect of heating "60 per cent" dynamite in an empty desiccator at 33° to 35° C. for 459 days.

Time in desiccator.	Loss of weight.	Time in desiccator.	Loss of weight.
Days.	*Per cent.*	*Days.*	*Per cent.*
4	0.13	77	5.35
7	.46	202	9.33
10	.80	243	11.13
13	1.10	331	13.32
16	1.40	418	16.75
20	1.75	459	17.52
41	3.40		

The weight of the dried sample at the time of beginning the heating in the empty desiccator was 1.9720 grams; its final weight after

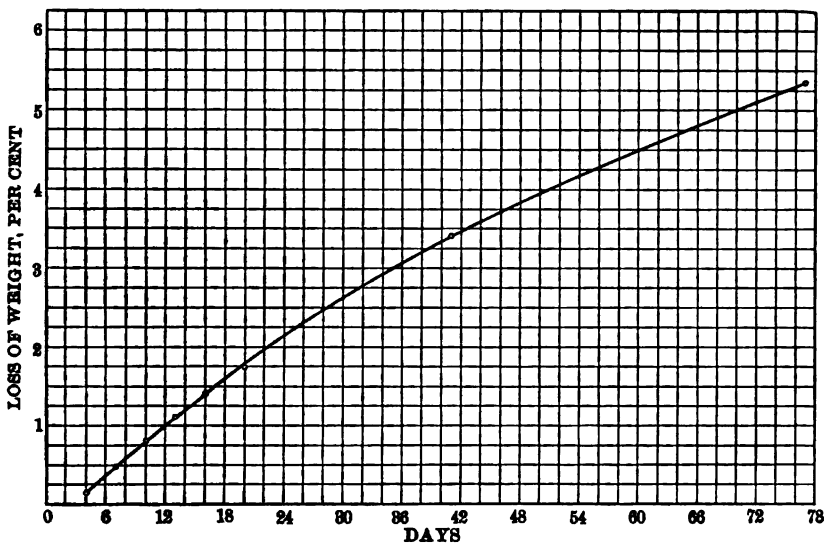

FIGURE 1.—Result of exposing dry "60 per cent" dynamite for 77 days in desiccator at 33° to 35° C. without desiccating agent.

459 days' heating was 1.6265 grams, a total loss of 0.3455 gram. The original dry sample contained 60.26 per cent, or 1.1883 grams, of nitroglycerin, whereas after heating for 459 days, only 0.8355 gram of nitroglycerin was found by analysis, showing a loss of 0.3528 gram of nitroglycerin. This figure agrees fairly well with the actual loss of weight, 0.3455 gram.

To summarize the results of this experiment, about one-third of the total quantity of nitroglycerin originally present was lost by exposure to a temperature of 33° to 35° C. for 459 days. The uni-

formity of the rate of loss is indicated by the curve in figure 2. Complete analysis of the sample showed that no change other than loss of nitroglycerin had occurred.

There is no doubt that the loss of nitroglycerin was due to volatilization and not to decomposition. On several occasions when the desiccator was opened to weigh the sample, a piece of potassium iodide-starch paper was at once exposed to the atmosphere within the desiccator, but in no case was any reaction for oxides of nitrogen obtained, nor could any odor of decomposition products be detected.

After the completion of the experiment the interior walls of the empty desiccator were washed with sulphuric acid and this acid transferred to the nitrometer in order to test it for the presence of nitroglycerin. A small amount of NO generated (insufficient for a reading) indicated the presence of nitroglycerin on the walls of the

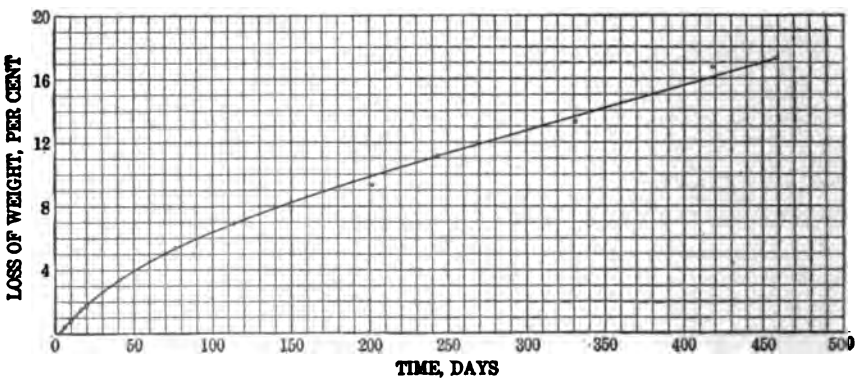

FIGURE 2.—Results of exposing "60 per cent" dynamite for 459 days in desiccator at 33° to 35° C. without desiccating agent.

desiccator, but most of the nitroglycerin volatilized from the dynamite sample had apparently escaped from the desiccator.

EFFECT OF VOLATILITY OF NITROTOLUENES.

The volatility of certain of the nitrosubstitution compounds may also have some effect on the results of the determination of moisture by desiccation. In order to investigate this point experiments were made on the more commonly used nitrotoluenes. The samples were desiccated over sulphuric acid for a number of days and the loss of weight noted at intervals.

The nitrotoluenes used for the tests were of the grade generally used in blasting explosives in this country. The "liquid" dinitrotoluenes and trinitroluenes are mixtures containing chiefly dinitrotoluenes and trinitrotoluenes, with more or less mononitrotoluene. Sample A, "liquid trinitrotoluene," contained only a trace of mono

compound, sample C, "liquid dinitrotoluene," contained 11.36 per cent of mono compound.

VOLATILITY OVER SULPHURIC ACID IN ORDINARY DESICCATORS.

The results of these experiments are given in the following tables. Similar samples are uniformly designated by letter, as A, B, C, throughout the tables and descriptions of tests:

Volatility of nitrotoluenes in desiccators in presence of sulphuric acid.

(Samples spread on watch glasses).

Sample.	Designation of sample.[a]	Test No.	Original weight of sample.	Loss in weight after desiccation for—				
				1 day.	3 days.	4 days.	7 days.	11 days.
			Grams.	*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
Mononitrotoluene (ortho).	G	1	3.72	0.0405	0.0766	0.1521	0.2225	0.2834
Do	G	2	8.31	.0341	.0656	.1197	.3091	.5426
Dinitrotoluene (crystals), melting point 66° to 68° C	F	3	1.00	.0014	.0015	.....	.0030	.0004
Trinitrotoluene (crystals), melting point 81° to 82° C	E	4	1.00	.0010	.0010	.....	.....	.....
"Liquid dinitrotoluene"[b]	C	5	5.73	.0082	.0203	.0279	.0548	.0864
Do	C	6	6.56	.0085	.0212	.0268	.0512	.0818
"Liquid trinitrotoluene"[c]	A	7	1.8539	.0033	.0037	.....	.0050	.0060

[a] Uniform throughout this and other tables.
[b] Commercial designation. Substance contains a trace of mononitrotoluene.
[c] Contains 11.36 per cent mononitrotoluene.

The results show that crystalline trinitrotoluene does not volatilize appreciably on desiccating; that crystalline dinitrotoluene is very slightly volatile, but the loss in three days is negligible; and that mononitrotoluene (ortho), on the other hand, is appreciably volatile, so that its presence in an explosive would introduce an error in the determination of moisture. The slight volatility of the liquid trinitrotoluene, and the considerably greater volatility of the liquid dinitrotoluene, are probably largely due to the content of mononitrotoluene in each.

EFFECT OF SURFACE AREA OF SAMPLE ON VOLATILITY OF NITROTOLUENES.

The effect of the surface area of the sample exposed in the desiccator was shown in the case of the liquid nitrotoluenes by distributing each sample over a layer of sand spread uniformly on a watch glass.

In the following determinations approximately 10 grams of dry (60-mesh) sand was spread on each watch glass and approximately 3 grams of the liquid sample allowed to drop onto the sand so that it was entirely moistened, but no accumulations of liquid were visible. The watch glasses were then placed in separate desiccators over sulphuric acid and weighed at intervals of two days.

Results of desiccation of liquid nitrotoluenes.

[Samples distributed over sand and placed in desiccators over sulphuric acid.]

Sample.	Sample No.[a]	Test No.	Original weight of sample.	Loss in weight after desiccation for—			
				2 days.	4 days.	6 days.	8 days.
			Grams.	*Gram.*	*Gram.*	*Gram.*	*Gram.*
Mononitrotoluene (ortho)	G	1	3.3767	0.1793	0.3138	0.4303	0.5421
Do	G	2	2.9936	.1745	.3725	.4849	.5840
Dinitrotoluene ("liquid")	C	3	3.6967	.0276	.0530	.0830	.1096
Do	C	4	3.0982	.0281	.0531	.0754	.0984
Trinitrotoluene ("liquid")	A	5	3.2256	.0071	.0143	.0161	.0225
Do	A	7	3.3519	.0064	.0137	.0159	.0214

[a] Uniform throughout this and other tables.

These results show that with an increase in the surface of the liquid exposed in the desiccator the rate of loss increases.

VOLATILITY OVER SULPHURIC ACID IN VACUUM DESICCATORS.

The volatility of nitrotoluenes when exposed in vacuum desiccators containing sulphuric acid was also investigated. Experiments were made on both crystalline and liquid dinitrotoluenes and trinitrotoluenes, but not on mononitrotoluene, there being no doubt in regard to the ready volatility of mononitrotoluene in a vacuum.

Samples of 1 gram each were weighed in small low-form beakers, and each beaker was placed in a separate Hempel vacuum desiccator containing fresh sulphuric acid. The sample of "liquid dinitrotoluene" (C) contained 11.36 per cent mononitrotoluene, the sample of "liquid trinitrotoluene" (B) contained 2.33 per cent mononitrotoluene, whereas the "liquid trinitrotoluene" (A) contained only a trace of mono compound. At intervals, as indicated in the table, the vacuum was relieved and the samples weighed.

The results were as follows:

Loss of weight of nitroluenes in vacuum desiccators.

[Quantity of sample taken for analysis, 1 gram.]

Time sample was exposed.	Loss in weight.				
	Trinitrotoluene[a] (crystals) (E).	Trinitrotoluene ("liquid") (A).	Trinitrotoluene ("liquid") (B).	Dinitrotoluene ("liquid") (C).	Dinitrotoluene[b] (crystals) (F).
Days.	*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
1	0.0007	0.0020	0.0050	0.0199	0.0028
2	.0007	.0050	.0104	.0471	.0064
4	.0007	.0076	.0174	.0831	.0074
5	.....	.0082	.0198	.0939	.0095
6	.....	.0093	.0225	.1023	.0112
7	.....	.0105	.0253	.1076	.0126
9	.....	.0125	.0289	.1161	.0152
10	.....	.0135	.0300	.1182	.0188
11	.....	.0140	.0318	.1216	.0205
12	.....	.0145	.0330	.1240	.0225
13	.....	.0150	.0339	.1260	.0241
14	.....	.0155	.0363	.1290	.0256

[a] Melting point, 81° to 82° C. [b] Melting point, 66° to 68° C.

The fact that the loss from pure crystalline trinitrotoluene is no greater than its probable moisture content, and that pure dinitrotoluene undergoes only a slight volatilization, whereas the loss in the case of the liquid materials is greater as the known content of mononitrotoluene is greater, indicates that the volatility of the "liquid nitrotoluenes" is due partly to loss of mononitrotoluene and partly to loss of dinitrotoluene. These results confirm the results of desiccation in ordinary desiccators.

After the 14 days' desiccation the samples of liquids were again examined for mononitrotoluene with the following results: "Liquid trinitrotoluene" (A), none; "liquid trinitrotoluene" (B), 0.83 per cent; "liquid dinitrotoluene" (C), 1.39 per cent.

As a further point of interest the above vacuum-desiccation experiments were repeated on the "liquid trinitrotoluene" (B) and on the "liquid dinitrotoluene" (C), in order to determine whether the mononitrotoluene could be entirely removed from them by continued treatment.

The results of these tests are shown in the table following.

Loss of weight of "liquid nitrotoluenes" in vacuum desiccators.

[Quantity taken for analysis, 1 gram.]

Period of exposure.	Loss in weight.				Period of exposure.	Loss in weight.			
	Trinitrotoluene (liquid). (B).		Dinitrotoluene (liquid). (C).			Trinitrotoluene (liquid). (B).		Dinitrotoluene (liquid). (C).	
Days.	*Gram.*	*Per cent.*	*Gram.*	*Per cent.*	*Days.*	*Gram.*	*Per cent.*	*Gram.*	*Per cent.*
1	0.0022	0.22	0.0159	1.59	17	0.0297	2.97	0.1251	12.51
3	.0044	.44	.0382	3.82	19	.0317	3.17	.1298	12.98
5	.0095	.95	.0623	6.23	21	.0360	3.60	.1348	13.44
7	.0132	1.32	.0829	8.29	25	.0432	4.32	.1414	14.18
10	.0187	1.87	.1036	10.36	27	.0448	4.48	.1434	14.34
11	.0208	2.08	.1080	10.80	29	.0474	4.74	.1461	14.61
13	.0238	2.38	.1156	11.56	31	.0504	5.04	.1502	15.02
15	.0272	2.72	.1209	12.09					

After 31 days of vacuum desiccation these samples were found to contain no mononitrotoluene. The total loss from each sample was, however, considerably greater than the amount of mononitrotoluene originally present, and, furthermore, the fact that constant weight was not obtained even after all of the mono compound had volatilized indicated a slight volatility of other ingredients of these liquid mixtures.

The curves in figure 3 indicate graphically the rate of loss of each of the two samples tested.

DETERMINATION OF MOISTURE IN EXPLOSIVES CONTAINING "LIQUID NITROTOLUENES."

A series of experiments was made to determine the extent to which the results of the usual methods for determining moisture in explosives are affected by the presence of the more or less volatile "liquid

nitrotoluenes." For this investigation a large sample (about 250 grams) of ordinary 45 per cent nitroglycerin dynamite was thoroughly mixed in a large porcelain dish and divided into five 50-gram parts, each of which was placed in a smaller porcelain dish. These five samples were then treated as follows:

1. Five grams of mononitrotoluene (ortho) was added, drop by drop, to sample 1 in such a manner as to distribute it through the sample as thoroughly as possible. The sample was then well mixed with a porcelain spoon and placed in a bottle.

2. Five grams of "liquid dinitrotoluene" (C), with a mononitrotoluene content of about 11 per cent, was added to sample 2 in the manner described for sample 1.

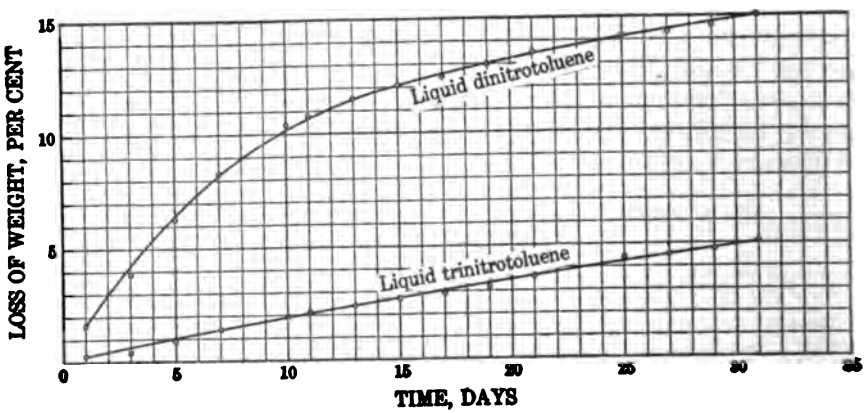

FIGURE 3.—Result of exposure of "liquid nitrotoluenes" in vacuum desiccators.

3. Five grams of "liquid dinitrotoluene" (D), with a mononitrotoluene content of about 4 per cent, was added as described above.

4. Five grams of "liquid trinitrotoluene" (A), practically free from mononitrotoluene, was added as described above.

5. No addition was made to sample 5, but it was mixed in the same manner as the other samples, so that the exposure to the atmosphere would be the same in each test. This sample was used for comparison with samples 1 to 4.

Moisture determinations were then made on each of these five samples (1) by desiccating over sulphuric acid in ordinary desiccators and (2) by desiccating over sulphuric acid in Hemple vacuum desiccators. The weight of the sample used for the determinations was 2.2 grams for samples 1 to 4, inclusive, and 2 grams for sample 5; samples 1 to 4 contained 0.1 gram of nitro compound for each gram of the dynamite. It was therefore assumed that any loss of weight in samples 1 to 4 greater than that of sample 5 was due to volatility of the nitro compounds. Each sample was placed in a separate desiccator.

The results of the determinations were as follows:

Loss in weight of "liquid nitrotoluenes" on desiccation over H_2SO_4 in ordinary desiccators.

Sample No.	Loss in weight after desiccation for—			Sample No.	Loss in weight after desiccation for—		
	3 days.	4 days.	6 days.		3 days.	4 days.	6 days.
	Gram.	*Gram.*	*Gram.*		*Gram.*	*Gram.*	*Gram.*
1	0.0795	0.0860	0.1055	4	0.0400	0.0400	0.0405
2	.0405	.0430	.0486	5	.0380	.0390	.0410
3	.0400	.0400	.0410				

Loss in weight of "liquid nitrotoluenes" on desiccation over H_2SO_4 in Hempel vacuum desiccators.

Sample No.	Loss in weight after desiccation for—					Sample No.	Loss in weight after desiccation for—				
	1 day.	2 days.	3 days.	4 days.	6 days.		1 day.	2 days.	3 days.	4 days.	6 days.
	Gram.	*Gram.*	*Gram*	*Gram.*	*Gram.*		*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
1	0.1185	0.1915	0.2255	0.2410	0.2530	4	0.0392	0.0422	0.0442	0.0457	0.0472
2	.0450	.0545	.0620	.0685	.0733	5	.0380	.0410	.0440	.0475	.0514
3	.0480	.0550	.0590	.0620	.0710						

These results show plainly that orthonitrotoluene is readily lost from explosives during the ordinary determination of moisture, causing the results to be abnormally high. In three days' desiccation in an ordinary desiccator, the loss of orthonitrotoluene was about equal to the amount of moisture present in the sample, and in four to six days' desiccation in vacuum, the total loss was equal to the sum of the actual amounts of moisture and orthonitrotoluene present.

The liquid dinitrotoluenes do not appreciably affect the result of the moisture determination in ordinary desiccators. In vacuum desiccators the error is small if the weighing is made at the end of 24 hours, whereas for longer periods of desiccation the loss increases gradually, and is greater as the content of mononitrotoluene in the "liquid dinitrotoluene" is greater.

"Liquid trinitrotoluene" does not affect the results in either ordinary or vacuum desiccators.

These determinations confirm the results obtained by desiccation of the nitrotoluenes alone, but are considered as indicating more exactly the behavior of these ingredients in explosives and their actual influence on the results of the moisture determination.

EFFECT OF VOLATILITY OF MONONITROBENZENE.

Mononitrobenzene is seldom used in blasting explosives because of its high degree of volatility; in fact, it is a constituent of only one of the explosives now on the "permissible" list, and in this

explosive is present in very small quantity. That its presence in an explosive would seriously affect the results of the moisture determination was shown by the following experiments:

Ten grams of mononitrobenzene that was exposed on a 3-inch watch glass in an ordinary sulphuric-acid desiccator lost 0.317 gram in 1 day, 0.702 gram in 3 days, and 2.543 grams in 10 days.

A similar sample that was desiccated over $CaCl_2$ lost 0.092 gram in 1 day, 0.197 gram in 3 days, and 0.386 gram in 10 days.

A sample distributed over sand on a watch glass and exposed for 10 days over sulphuric acid lost about 40 per cent in weight, and over calcium chloride about 20 per cent.

In a vacuum desiccator with sulphuric acid mononitrobenzene was completely volatilized, 10 grams on a watch glass evaporating completely in 10 days, and 2.5 grams spread over a layer of sand evaporating completely in 3 days.

EFFECT OF MATERIALS CONTAINING WATER OF CRYSTALLIZATION.

Salts containing water of crystallization effectually prevent any reliable determination of moisture by the usual method of desiccation, because all of such salts as are commonly used in explosives lose a portion of their water of crystallization on exposure to a dry atmosphere, and it is impossible to differentiate between the loss due to evaporation of hygroscopic moisture and that due to water of crystallization.

RESULTS OF TESTS WITH MAGNESIUM SULPHATE AND POTASSIUM ALUM.

Tests were made with pure crystallized magnesium sulphate and potassium alum to determine whether any definite proportion of the water of crystallization would be removed by desiccation over either sulphuric acid or calcium chloride.

The percentage loss of weight according to the number of molecules of water lost should be as follows:

Theoretical loss of weight from magnesium sulphate and potassium alum for each molecule of water lost.

Number of molecules of H_2O lost.	Theoretical loss in weight.		Number of molecules of H_2O lost.	Theoretical loss in weight.	
	$KAl(SO_4)_2 \cdot 12H_2O$.	$MgSO_4 \cdot 7H_2O$.		$KAl(SO_4)_2 \cdot 12H_2O$.	$MgSO_4 \cdot 7H_2O$.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
1	3.79	7.30	7	26.53	51.10
2	7.58	14.60	8	30.32	.....
3	11.37	21.90	9	34.11	.....
4	15.16	29.20	10	37.90	.....
5	18.95	36.50	11	41.69	.....
6	22.74	43.80	12	45.48	.....

Samples of these salts were ground to pass a 20-mesh sieve, exposed on watch glasses in desiccators, and the loss of weight noted. The results were as follows:

Loss of weight from magnesium sulphate and potassium alum on desiccation over sulphuric acid and calcium chloride.

Time of desiccation.	Loss of weight.			
	$KAl(SO_4)_2.12H_2O$.		$MgSO_4.7H_2O$.	
	Over H_2SO_4.	Over $CaCl_2$.	Over H_2SO_4.	Over $CaCl_2$.
Days.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
3	8.68 to 9.86	3.42 to 3.94	14.15 to 14.51	9.32 to 9.87
8	.....	13.41 to 14.96	25.72 to 29.11	14.71 to 18.35
9	28.08 to 30.84	.....	.....	.....
12	.....	17.90 to 20.05	.....	19.77 to 20.55

DISCUSSION OF RESULTS OF EXPERIMENTS.

The above results indicate the impossibility of correcting the total loss of weight found by desiccating an explosive containing salts carrying water of crystallization for the amount of such water of crystallization lost by a given treatment.

Furthermore, it is apparent that it is impossible to determine the total hygroscopic moisture plus water of crystallization by drying in an oven at temperatures higher than atmospheric, because under such conditions other ingredients, such as nitroglycerin and ammonium nitrate, would be more or less volatilized.

It is therefore necessary to determine all constituents other than moisture by direct methods and estimate the content of water by difference. In other words the remainder obtained by deducting the sum of all constituents other than water from 100 per cent is assumed to be the total water content of the explosive. For this purpose the constituent to which the water of crystallization belongs may be calculated as containing its full quota of water of crystallization (for example, magnesium sulphate as $MgSO_4.7H_2O$), and the difference from 100 per cent reported as moisture, or the crystallized salt may be calculated as anhydrous and the difference reported as water of crystallization plus moisture. The latter method is probably the more correct, as it is safe to assume that the crystallized salt has undergone some loss of its water by efflorescence before being incorporated in the explosive mixture.

In either case the algebraic sum of all of the errors in the determinations of the other ingredients of the explosive is thrown on the water when the latter is taken by difference.

In many cases a more correct value for the actual hygroscopic moisture present may be obtained by calculation, assuming certain

average values for the percentage of moisture present in the various ingredients of the mixture.

The average values for the moisture content of the chief ingredients of such explosives, according to the general practice of manufacturers in this country, are approximately as follows:

Approximate average moisture content of constituents of explosives.

	Per cent.
Nitroglycerin	0.5
Sodium nitrate	.5
Ammonium nitrate	.3
Wood pulp	5.0
Corn meal	12.0
Wheat flour	10.0

If these values be assumed to be correct, and the proportion of each constituent of the explosive except moisture has been determined, an approximation to the moisture content of the explosive may be calculated. The following table shows, for a number of explosives of different types made by different manufacturers, a comparison of the calculated moisture content with the result of the determination of moisture by the usual desiccation method, and with that obtained by difference from 100 per cent, as proposed above.

Moisture content of various explosives, as obtained by desiccation, by difference, and by calculation.

Sample No.	Type of explosive.	Moisture content.		
		By desiccation.	By difference.	By calculation.
		Per cent.	*Per cent.*	*Per cent.*
1	Dynamite (40 per cent strength)	0.90	.....	0.93
2	.....do	.94	.....	1.00
3	NH_4NO_3 dynamite (40 per cent strength)	.92	.....	.75
4	.....do	.92	.....	.76
5	Permissible explosive (NH_4NO_3 class)	.44	.....	.49
6	.....do	.70	.....	.74
7	Permissible explosive (hydrated class)	.....	2.10	2.41
8	.....do	.....	2.25	2.24
9	.....do	.....	1.16	1.05
10	.....do	.....	.20	.41
11	.....do	.....	.19	.25
12	.....do	.....	.27	.97
13	.....do	.....	1.00	1.80

For most of the samples the calculated result agrees quite well with the results by desiccation or by difference. The discrepancy of results shown by samples 12 and 13 is probably due to the fact that the crystallized magnesium sulphate in those explosives had partly effloresced, causing the moisture determined by difference to be too low. Cases have been noted where the same cause resulted in a negative value for "moisture by difference." The only feasible manner of reporting the analysis of such explosives is to calculate the crys-

tallized ingredient as anhydrous and estimate by difference the combined moisture and water of crystallization.

EXTRACTION WITH ETHER.

It has been indicated on page 13 that the principal substances that may be found in the ether extracts of permissible explosives are nitroglycerin, nitropolyglycerin, various nitrosubstitution compounds, sulphur, oils, vaseline or paraffin, and resins. Small amounts of oils and resins extracted from the wood pulp or cereal products in permissible explosives are, as in the ordinary types of dynamites, generally found in the ether extract, in addition to materials of similar nature that may constitute actual ingredients of the explosive.

METHOD OF EXTRACTION.

The removal of ether-soluble ingredients from all permissible explosives is carried out according to the general method employed for dynamites.[a] Samples of 6 to 10 grams of the explosive in its original condition are weighed in Gooch crucibles with asbestos mats or in suitable porous filtering crucibles, and extracted with ether in a Wiley extractor or other convenient form of reflux-condenser extraction apparatus.

The extraction with ether usually requires about three-quarters of an hour, but it is always advisable to insure that extraction is complete by evaporating a small quantity of the ether passing through the crucible. If the ether completely evaporates, leaving no residue, the extraction is complete.

The crucibles containing the residue insoluble in ether are then removed from the extraction apparatus, the excess of ether in the residue is removed by suction, and the crucibles with their contents are placed at once in a drying oven.

DRYING OF INSOLUBLE RESIDUE.

The method of drying this residue depends upon whether or not the qualitative analysis has shown the presence of ammonium salts or other substances that may be volatilized or decomposed on heating. If the explosive does not contain ammonium salts, it is customary to dry the residue at a temperature of 100° C. for 5 hours, a procedure that has been found to insure constant weight. A longer period of drying, even overnight, will not cause any appreciable additional loss in weight, and is often found convenient.

If ammonium salts are present, the residue is dried at a temperature of 70° C., as it has been shown[b] that, especially in the presence

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, pp. 30–32.

[b] Snelling, W. O., and Storm, C. G., op. cit., pp. 59–60.

of zinc oxide, the antacid generally employed in ammonium nitrate explosives, an appreciable loss of the ammonium salts results from drying at 100° C. At 70° the loss was found to be practically negligible, even on drying for a period of 24 hours.

Organic nitrates, such as nitrostarch or nitrocellulose, may, if present, also undergo some decomposition if the residue is dried as long as 5 hours at 100° C. When the qualitative examination has indicated the presence of either of these substances, it is advisable, therefore, to dry the residue at 70° instead of 100°.

After the drying is completed the crucibles are transferred from the drying oven to sulphuric-acid desiccators, allowed to cool for 15 to 20 minutes, and immediately weighed.

The loss of weight represents the ether-soluble material plus the moisture originally contained in the sample before extraction. If salts containing water of crystallization are a constituent of the explosive, this loss of weight also includes part of the combined water in addition to the free moisture. For example, crystallized magnesium sulphate, $MgSO_4.7H_2O$, if heated sufficiently long at 100° C., loses 5 molecules of its water of crystallization. In the absence of such hydrated salts the total loss obtained by extraction with ether, minus the moisture determined by desiccation, is taken as the amount of ether-soluble material, but when hydrated salts are present the direct weight of residue left on evaporation of the ether solution should be taken as representing the total ether-soluble material.

MODIFIED TUBE FOR WILEY EXTRACTION APPARATUS.

A modified glass tube for use with the Wiley extraction apparatus is shown in figure 4. This form of tube was suggested to the writer by F. B. Stieg, chemist of the Aetna Powder Co., Aetna, Ind., who had devised it for his own use. These tubes are in use in the laboratory of the Bureau of Mines, and are found especially suitable for ether extractions of explosives containing solids, such as trinitrotoluene and sulphur, which are soluble in ether and which crystallize out in the extraction tube during the process of extraction.

When the usual style of extraction tube[a] is used it is necessary to transfer the ether extract to small, weighed beakers before evaporating the ether. The presence of crystals in the extract renders this transference more or less troublesome and necessitates the use of an unusual amount of ether for completely removing all of the crystallized material from the tube.

The modified tube shown in figure 4 is approximately the same size as the usual extraction tube, but is made in two parts, the bottom part

[a] For description and view, see Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, pp. 31, 32.

being 2½ inches deep and 1¾ inches inside diameter, and made of glass of such thickness that its weight is approximately 30 grams. The two parts are connected by means of a wide ground joint between the outer surface of the bottom part and the inner surface of the upper part. This ground joint becomes wet with ether during the extraction and is thus rendered perfectly tight.

In using this extraction tube the bottom part is carefully dried and weighed before beginning the extraction. After the extraction is completed the bottom part, containing the ether extract, is removed, placed under the bell-jar evaporator, and the ether evaporated in a current of dry air. The ether-soluble extracted material is then in condition to be weighed, unless the explosive contained a considerable amount of moisture, in which case desiccation is necessary in order to obtain approximately constant weight.

Naturally this style of tube can not be suspended from a ring support, but must be allowed to rest on the top of the heating bath in order to prevent the bottom part of the tube from becoming detached.

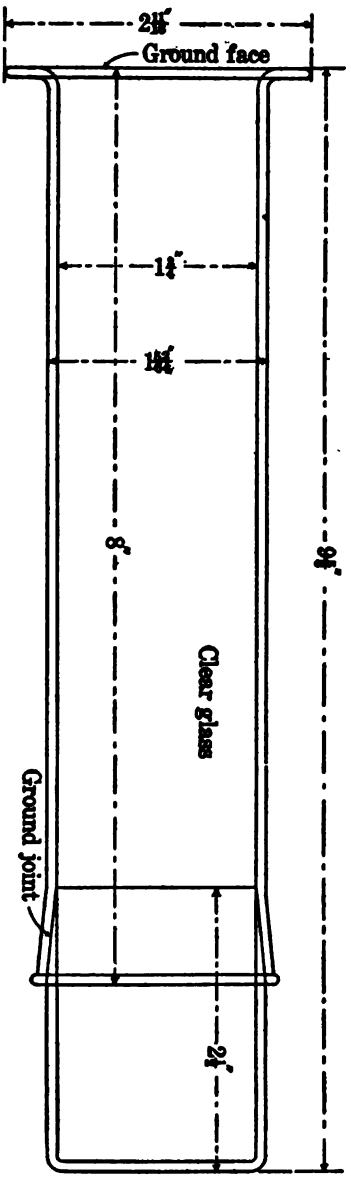

FIGURE 4.—Modified glass tube for use with Wiley extraction apparatus.

EVAPORATION IN THE BELL-JAR EVAPORATOR.

The apparatus used in the bureau's laboratory for evaporating the ether extract is shown in figure 5. It is known as the bell-jar evaporator and was devised by A. L. Hyde, assistant explosives chemist. The beaker, *a*, containing the ether solution is placed on a ground-glass plate, *b*, and covered by a glass bell jar, *c*, 6 inches in diameter and 8 inches high, with tubulures at the top and on the side, each opening being fitted with a perforated stopper and delivery tube. A current of compressed air, dried by passing through con-

centrated sulphuric acid in a drying cylinder, *d*, is passed through the delivery tube in the top of the bell jar, the lower end of the tube being adjusted about one-half inch above the surface of the ether solution in the beaker. A drying cylinder, *e*, filled with granular soda lime is connected between the sulphuric acid cylinder and the bell jar in order to prevent traces of acid from being mechanically carried over. The upper and lower ends of the soda-lime tower are charged with cotton, *f*, which serves as a filter for the air. The air current is so regulated that a marked "dimple" is made in the surface of the solution, care being taken to avoid loss by spattering through using too high an air pressure. The ether vapors pass out through the tube in the side tubulure and may be conducted out of the laboratory.

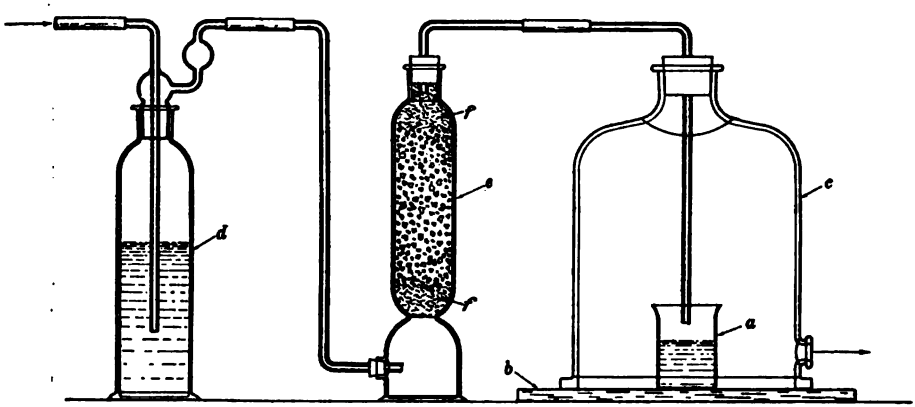

FIGURE 5.—Apparatus for evaporating ether extract.

The advantage in the use of this method of evaporating ether solutions of nitroglycerin lies in the fact that the low temperature produced by the rapid evaporation of the ether minimizes the volatilization of the nitroglycerin and, the air current being dry, there is no deposition of moisture from the air, so that it is only necessary to desiccate the residue, after evaporation of the ether, for a sufficient time to remove the original moisture.

A weighed quantity of nitroglycerin may be dissolved in 50 c. c. of ether and the ether evaporated completely in a few hours with a loss of less than 1 milligram of nitroglycerin, as shown by the nitrometer determinations given on page 38.

ANALYSIS OF ETHER EXTRACT.

The duplicate portions of the ether-soluble material, after all the ether has been removed, as determined by check weighings, are then ready for examination. If qualitative tests have indicated the pres-

ence of nitroglycerin, one of the duplicate samples is used for determining nitroglycerin by means of the nitrometer, as described in Bulletin 51,[a] and the other sample is used for the determination of any ingredients other than nitroglycerin. Frequently it is necessary to extract additional samples of the original explosive with ether, in order to obtain a sufficient number of samples of the ether extract for the necessary determinations.

EFFECT OF VOLATILITY OF NITRO COMPOUNDS AND NITROGLYCERIN ON THE RESULTS OF THE ANALYSIS.

The accuracy of the analysis of the ether-soluble part of most permissible explosives is more or less affected by certain properties of substances usually present. For example, nitroglycerin and some of the nitrosubstitution products are appreciably volatile under certain conditions, and in the determination of nitroglycerin by means of the nitrometer some of the other constituents may take up appreciable amounts of the nitric acid liberated from the nitroglycerin, thereby introducing an error in the nitroglycerin determination.

These chief sources of error have been investigated and the results of experiments made are here described.

LOSS OF NITROGLYCERIN DURING EVAPORATION OF THE ETHER SOLUTION.

The subject of loss of nitroglycerin by volatilization has been considered in Bulletin 51,[b] where experiments are described showing that spontaneous evaporation of the ether at room temperature results in very slight loss of nitroglycerin. The main objection to this method of evaporation is the fact that an appreciable amount of moisture from the air is deposited with the extract, necessitating desiccation for considerable periods. The use of the bell-jar evaporator described in a preceding paragraph prevents the deposition of moisture. A large number of tests have been carried out to determine the loss of nitroglycerin in evaporating ether extracts with the bell jar.

Weighed samples of nitroglycerin were each dissolved in 50 c. c. of ether in 100-c. c. beakers. The ether was volatized by subjecting the solution to a current of dry air for a definite length of time in the bell-jar evaporator, then the residue of nitroglycerin, containing possible traces of moisture and ether, was weighed, and the actual proportion of nitroglycerin determined by means of the nitrometer,

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, pp. 35–38.

[b] Snelling, W. O., and Storm, C. G., op. cit., pp. 39–41.

the use of which is fully described in Bulletin 51.[a] A number of such determinations are shown in the following table, in which column 1 gives the quantity of nitroglycerin (99.6 per cent pure) taken, column 2 the time of treatment of the ether solution with the air current, columns 3 and 4 the variation of the final weight from the original weight of nitroglycerin, column 5 the quantity of nitroglycerin (calculated to original purity, 99.6 per cent) in the evaporated residue as determined by means of the nitrometer, and column 6 the actual loss of nitroglycerin, or difference between the results in column 1 and column 5.

Loss of nitroglycerin by evaporation of ether solutions by means of dry-air current in bell-jar evaporator.

Test No.	Quantity of nitroglycerin taken for test.	Time of evaporation.	Change in weight.		Quantity of nitroglycerin in residue as determined by nitrometer.	Loss of nitroglycerin.
			Gain.	Loss.		
	1	2	3	4	5	6
	Gram.	*Hours.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
1	0.7152	2	0.0033	.....	0.7148	0.0004
2	.7025	2	.0001	.....	.7016	.0009
3	.7067	3	.....	0.0003	.7067	.0000
4	.7091	3	.0004	.....	.7077	.0014
5	.7041	3	.....	.0002	.7023	.0018
6	.7271	4	.0003	.....	.7263	.0008
7	.7014	4	.0005	.....	.7012	.0002
8	.7038	4	.....	.0005	.7028	.0010
9	.7127	4	.....	.0006	.7105	.0022
10	.7260	18	.....	.0065	.7236	.0024
11	.7019	18	.....	.0064	.6974	.0045

The results indicate that by evaporating the ether extracts in a dry air current, using the bell-jar evaporator, it is possible to remove practically all of the ether in a few hours without serious loss of nitroglycerin, and without absorption of moisture, obviating the necessity of desiccating the evaporated residue before weighing.

In most of the results cited the weight of the evaporated residue is greater than that of the original sample, owing to some deposition of moisture or to ether residue; in other tests, for example, Nos. 10 and 11, the weight of evaporated residue is less than the weight of 99.6 per cent nitroglycerin calculated from the nitrometer determination, because some of the moisture present in the original nitroglycerin had been evaporated by the long-continued treatment and the purity of the nitroglycerin actually increased thereby. The ether used in these experiments was good quality U. S. P. ether and contained a negligible proportion of nonvolatile residue.

[a] Snelling, W. O., and Storm, C. G., op. cit., p. 38

EFFECT OF RATE OF AIR CURRENT ON EVAPORATION OF NITROGLYCERIN.

The rate of evaporation and the loss of nitroglycerin for a given period of treatment with the dry air current naturally depend on the rate of the air current. The table following shows the results of two tests in which the samples of nitroglycerin were each dissolved in 50 c. c. of ether and the ether evaporated as above described. A more rapid air current was used to evaporate sample 2, so that in a given period of time the volume of air passed over sample 2 was greater than that passed over sample 1, as indicated by the passage of air through the sulphuric acid in the drying cylinders.

Variation in rate of loss of nitroglycerin by evaporation of ether solutions in dry air current.

Time of evaporation.	Sample 1.			Sample 2.	
	Weight of nitroglycerin.	Change in weight.		Weight of nitroglycerin.	Loss in weight.
		Gain.	Loss.		
Hours.	*Grams.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
0	1.2278			0.7019	
3	1.2547	0.0269		.7027	[a] 0.0008
4	1.2390	.0112			
5	1.2345	.0067		.7018	.0001
6	1.2325	.0047		.7016	.0003
7	1.2299	.0021		.7007	.0012
8	1.2270		0.0008		
9	1.2269		.0009	.7002	.0017
10	1.2271		.0007	.6999	.0020
11	1.2277		.0001	.6986	.0033
12	1.2265		.0013	.6976	.0043
13	1.2262		.0016	.6973	.0046
14	1.2260		.0018	.6968	.0051
15	1.2258		.0020	.6966	.0053
16	1.2258		.0020		
17	1.2257		.0021	.6961	.0058
18				.6955	.0064

[a] Gain.

The results show that a rapid air current removes the ether in a shorter time (3 to 5 hours), but that for long periods of treatment more nitroglycerin is lost than with a slower air current.

It is important that the air current should not be strong enough to cause mechanical loss of the nitroglycerin by spattering.

LOSS OF NITROTOLUENES DURING EVAPORATION OF THE ETHER SOLUTION.

Experiments were also made to determine to what extent the various nitrotoluenes are lost by volatilization during evaporation of the ether from ether solutions containing them. In the tests described below approximately 1 gram of each sample was dissolved in 50 c. c. of U. S. P. ether in a 100 c. c. beaker and the ether evaporated in the bell-jar evaporator, weighings being made at intervals in order to determine any loss of nitro compound.

Results of experiments to determine loss of nitrotoluenes by evaporation of ether solutions with a dry air current in bell-jar evaporator.

Time of evaporation.	Mononitrotoluene (G) (ortho).		Mononitrotoluene (H) (para).		Dinitrotoluene [a] (F) (crystals).		
	Weight of sample.	Loss in weight.	Weight of sample.	Loss in weight.	Weight of sample.	Change in weight. Gain.	Change in weight. Loss.
Hours.	*Grams.*	*Gram.*	*Grams.*	*Gram.*	*Grams.*	*Gram.*	*Gram.*
0	1.0025	.....	1.0072	.....	1.0000	.....	.....
2	.....	.....	.9905	0.0167	1.0285	0.0285	.....
3	.9450	0.0575	.9640	.0432	1.0020	.0020	.....
4	.9146	.0879	.9375	.0697	1.0009	.0009	.....
5	.8850	.1175	.9103	.0969	1.0003	.0003	.....
6	.8575	.1450	.8815	.1257	.9995	.....	0.0005
7	.....	.....	.8468	.1604	.9987	.....	.0013
8	.8000	.2025	.8397	.1675	.9980	.....	.0020
9	.7770	.2255	.8275	.1797	.9976	.....	.0024
10	.7450	.2575	.8175	.1897	.9976	.....	.0024
11	.7184	.2841	.8047	.2025	.9972	.....	.0028
12	.6914	.3111	.7915	.2157	.9967	.....	.0033

Time of evaporation.	Trinitrotoluene [b] (E) (crystals).		Dinitrotoluene (D) (liquid).			Dinitrotoluene (C) (liquid).	
	Weight of sample.	Gain in weight.	Weight of sample.	Change in weight. Gain.	Change in weight. Loss.	Weight of sample.	Loss in weight.
Hours.	*Grams.*	*Gram.*	*Grams.*	*Gram.*	*Gram.*	*Grams.*	*Gram.*
0	1.0000	.....	1.0012	.....	.....	1.0110	.....
2	.....	.....	.....	.....	.....	.....	.....
3	1.0000	0.0000	1.0354	0.0342	.....	1.0505	[c] 0.0395
4	1.0000	.0000	1.0183	.0171	.....	1.0240	[c] .0130
5	1.0000	.0000	1.0102	.0090	.....	1.0102	.0008
6	1.0000	.0000	1.0062	.0050	.....	1.0030	.0080
7	.....	.....	1.0023	.0011	.....	.9959	.0151
8	.9995	[d] .0005	.9961	.....	0.0051	.9875	.0235
9	.....	.....	.9944	.....	.0068	.9852	.0258
10	.....	.....	.9933	.....	.0079	.9825	.0285
11	.....	.....	.9924	.....	.0088	.9795	.0315
12	.....	.....	.9915	.....	.0097	.9780	.0330

Time of evaporation.	Trinitrotoluene (B) (liquid).			Trinitrotoluene (A) (liquid).		
	Weight of sample.	Change in weight. Gain.	Change in weight. Loss.	Weight of sample.	Change in weight. Gain.	Change in weight. Loss.
Hours.	*Grams.*	*Gram.*	*Gram.*	*Grams.*	*Gram.*	*Gram.*
0	1.0137	.....	.....	1.0225	.....	.....
2	.....	.....	.....	.....	.....	.....
3	1.0450	0.0313	.....	1.0650	0.0425	.....
4	1.0303	.0166	.....	1.0450	.0225	.....
5	1.0250	.0113	.....	1.0355	.0130	.....
6	1.0215	.0078	.....	1.0305	.0080	.....
7	1.0175	.0038	.....	1.0266	.0041	.....
8	1.0130	.....	0.0007	1.0225	.0000	.....
9	1.0108	.....	.0029	1.0217	.....	0.0008
10	1.0095	.....	.0042	1.0214	.....	.0011
11	1.0074	.....	.0063	1.0210	.....	.0015
12	1.0061	.....	.0076	1.0200	.....	.0025

[a] Melting point 66° to 68° C. [b] Melting point 81° to 82° C. [c] Gain. [d] Loss.

The results are what might be expected from the results of determination of volatility in desiccators, described in pages 24 to 29.

The loss of crystalline trinitrotoluene during evaporation by means of the air current was negligible. The same was true for crystalline dinitrotoluene for periods amply sufficient to remove all ether, although the gradual loss beyond this point indicates that dinitrotoluene is slightly volatile. Both orthomononitrotoluene and paramononitrotoluene volatilized appreciably, even before the evaporation of the ether was complete. The evaporation of the ether from the "liquid dinitrotoluenes" and "liquid trinitrotoluenes" apparently proceeded more slowly than from the crystalline compounds, 5 to 8 hours' treatment being necessary before the liquid samples attained approximately their original weight.

On further treatment with the air current the "liquid trinitrotoluenes" underwent a slight loss of weight and the "liquid dinitrotoluenes" a somewhat greater loss. In general, it is noted that the loss of weight is greater as the percentage of mononitrotoluene is greater.

CONCLUSIONS REGARDING LOSS BY EVAPORATION OF THE ETHER EXTRACT.

The experiments indicate that by the use of the bell-jar evaporator, with a fairly rapid current of dry air, ether solutions may be evaporated in about 5 to 6 hours without an appreciable loss of either nitroglycerin or nitrotoluenes, provided that no great proportion of mononitrotoluene is present. Seven to eight hours may be necessary for complete removal of the ether from "liquid trinitrotoluene," and even an 8-hour treatment will not cause any appreciable loss of nitroglycerin.

EFFECT OF VARIOUS SUBSTANCES ON THE DETERMINATION OF NITROGLYCERIN BY MEANS OF THE NITROMETER.

It has been shown[a] that mononitrotoluene, which is usually a constituent, in greater or less proportion, of most of the commercial "liquid nitrotoluenes" used in blasting explosives, interferes with the direct determination of nitroglycerin by means of the nitrometer. Other mononitro compounds affect the determination in the same manner, by combining with part of the nitric acid resulting from the breaking up of the nitroglycerin. Certain substances other than nitrosubstitution compounds, which may be found in the ether extracts of explosives, have the same effect. A series of experiments were made in order to determine the extent to which the determination of nitroglycerin in the nitrometer is affected by the presence of such substances as may be contained with the nitroglycerin in the ether extract.

[a] Storm, C. G., Effect of nitrotoluenes on the determination of nitroglycerin by means of the nitrometer: Original Communications, 8th Int. Cong. App. Chem., vol. 4, 1912, p. 117.

TESTS OF ETHER-SOLUBLE SUBSTANCES.

The substances used in these tests included the more common nitro-substitution compounds, rosin (colophony), vaseline, paraffin, and various mineral and vegetable oils. A weighed quantity of the material to be tested was placed in a small beaker, a weighed quantity of either nitroglycerin or potassium nitrate of known nitrogen content (18.46 and 13.84 per cent, respectively) added, and the whole treated with about 10 c. c. of strong sulphuric acid, approximately 96 per cent pure. The mixture was well stirred with a small glass rod and transferred to the generating bulb of the nitrometer, fresh sulphuric acid being used to completely remove any undissolved material left in the beaker. In most of the tests 20 to 30 c. c. of sulphuric acid was sufficient. After shaking the mixture in the generator until the evolution of nitric oxide (NO) was complete, the gas was transferred to the reading tube and the volume read. This reading is expressed in terms of weight of nitrogen found (grams) in column 4 of the following table of results. The figures given in column 5 for the weight of nitrogen lost per gram of ingredient (column 3) are obtained by deducting the weight of nitrogen found (column 4) from the weight of nitrogen present (weight of KNO_3 times $\frac{13.84}{100}$, or weight of nitroglycerin times $\frac{18.46}{100}$), and dividing the remainder by the weight of substance as given in column 3. Column 5 also shows the equivalent of the nitrogen loss in terms of nitroglycerin; or, in other words, the loss of nitroglycerin which would result from the presence of 1 gram of the substance indicated in column 3.

Results of determinations of nitrogen in the nitrometer in the presence of various ether-soluble substances.

VASELINE.

Weights of ingredients of mixture.			Results of determination.			
KNO_3.	Nitroglycerin.	Substance tested.	Weight of N found.	Weight of N lost per gram of substance tested.	Average loss of N per gram of substance tested.	Equivalent loss of nitroglycerin per gram of substance tested.
1	2	3	4	5	6	7
Gram.	*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
1.0000	.....	0.4006	0.1302	0.0205		
1.0000	.....	.2052	.1335	.0239	0.0218	0.1180
1.0000	.....	.1046	.1364	.0191		
.....	0.7192	.2010	.1281	.0239		

Results of determinations of nitrogen in the nitrometer in the presence of various ether-soluble substances—Continued.

PARAFFIN.

Weights of ingredients of mixture.			Results of determination.			
KNO_3.	Nitroglycerin.	Substance tested.	Weight of N found.	Weight of N lost per gram of substance tested.	Average loss of N per gram of substance tested.	Equivalent loss of nitroglycerin per gram of substance tested.
1	2	3	4	5	6	7
Gram.	*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*	*Gram.*
1.0000	.....	0.1670	0.1358	0.0155	0.0157	0.0849
.....	0.7624	.1012	.1391	.0158		

CASTOR OIL.

1.2000	.....	0.1688	0.1564	0.0575	0.0583	0.3151
.....	0.8491	.1557	.1475	.0591		

COTTONSEED OIL.

1.0000	.....	0.4229	0.1025	0.0849	0.0851	0.4589
1.0000	.....	.2311	.1187	.0852		

ENGINE OIL.

1.0000	.....	0.1050	0.1334	0.0476	0.0482	0.2605
1.0000	.....	.3192	.1229	.0485		
.....	0.7428	.1592	.1294	.0484		

CORN OIL.

1.0000	.....	0.1054	0.1316	0.0645	0.0623	0.3368
.....	0.8416	.2044	.1430	.0600		

ROSIN (COLOPHONY).

.....	0.7552	0.1006	0.1316	0.0775	0.0759	0.4103
.....	.7394	.1008	.1289	.0744		
.....	.7590	.2017	.1248	.0758		

MONONITRONAPHTHALENE.

1.0000	.....	0.1000	0.1219	0.1650	0.1621	0.8762
1.0000	.....	.2012	.1061	.1605		
1.0000	.....	.3000	.0894	.1633		
1.0000	.....	.1006	.1219	.1640		
1.0000	.....	.1527	.1140	.1598		
.....	0.7846	.2520	.1045	.1600		

MONONITROBENZENE.

.....	1.3190	1.0017	0.1276	0.1157	0.1155	0.6243
.....	1.3053	.9981	.1259	.1152		

DINITROBENZENE.

1.0000	.....	0.1966	0.1384	0.0000	0.0000	.....
.....	0.7139	.9993	.1311	.0007	.0007	.....

DISCUSSION OF RESULTS OF TESTS.

The above results show that such materials as rosin, vaseline, paraffin, and mineral and vegetable oils are all capable of being nitrated, and hence take up part of the nitric acid liberated from the nitroglycerin by the reaction in the nitrometer. Furthermore, the proportion of nitrogen thus combined by such materials is practically a constant quantity for each gram of the material, regardless of the quantity present.

All mononitro compounds are probably capable of becoming further nitrated under the conditions existing in the nitrometer, and the tests made indicate that in each instance the mononitro compound is nitrated to a definite degree, taking up either one or two more nitro groups. The previous work of the writer,[a] referred to in a preceding paragraph, showed that the mononitrotoluenes are quantitatively converted to dinitrotoluenes but that dinitrotoluenes and trinitrotoluenes are not acted on in the nitrometer. The results in the table show analogous action of mononitrobenzene and dinitrobenzene; 1 gram of mononitrobenzene absorbed 0.1152 gram nitrogen, whereas for conversion to dinitrobenzene it should absorb 0.1138 gram. Dinitrobenzene was practically without effect on the determination. Mononitronaphthalene, however, was converted by the reaction in the nitrometer to trinitronaphthalene, 1 gram of the mono compound taking up 0.1621 gram of nitrogen, whereas the quantity theoretically required for the conversion to trinitronaphthalene is 0.1597 gram.

This conclusion was confirmed by the following experiment: 2 grams of mononitronaphthalene was added to 2.4 grams potassium nitrate and the mixture treated in a beaker with about 25 c. c. of 96 per cent sulphuric acid, stirred, and let stand for 2 hours until cooled to room temperature. The mixture was then poured into 500 c. c. water, the resulting precipitate filtered off, washed, and dried to constant weight in a vacuum desiccator. The product weighed 2.94 grams, whereas if the mono compound had been completely converted to trinitronaphthalene the weight should have been 3.04 grams. The original mononitronaphthalene, which theoretically contained 8.09 per cent nitrogen, was found to contain 8.16 per cent nitrogen, and the product obtained by the above reaction contained 15.67 per cent nitrogen, whereas trinitronaphthalene theoretically contains 15.97 per cent of nitrogen.

The interference of ether-soluble substances with the determination of the nitroglycerin may be avoided if any substances in the ether extract other than nitroglycerin are determined by a direct method and the nitroglycerin determined by difference. The direct

[a] Storm, C. G., Effect of nitrotoluenes on the determination of nitroglycerin by means of the nitrometer: Original Communications; 8th Int. Cong. App. Chem., vol. 4, 1912, p. 117.

determination of these ether-soluble materials is discussed in pages 46 and 47.

TESTS TO ASCERTAIN SOLUBILITY OF ETHER-SOLUBLE SUBSTANCES IN NITROGLYCERIN.

A series of tests was made to ascertain the extent to which the solubility of these ether-soluble substances in the nitroglycerin would affect the determination of the purity of the nitroglycerin separated from such substances by filtration. About 0.5 gram of the substance taken for test was added to 2 c. c. of nitroglycerin of known nitrogen content (18.42 per cent), the whole dissolved in 50 c. c. of ether, the ether evaporated by the method described for treating the ether extract of an explosive (pp. 35 and 36), the evaporated material filtered through a paper filter, and the clear filtrate tested in the nitrometer. From the result of the nitrogen determination it is readily ascertained whether an appreciable quantity of the substance has been dissolved by the nitroglycerin. For example, a determination giving a nitrogen content of 18.32 per cent indicates that 1 per cent of the substance is dissolved in the filtered nitroglycerin; 18.13 per cent N indicates that 2 per cent of the substance has been dissolved, and so on, provided that any nitrogen taken up by the dissolved material is disregarded.

The table following shows the results of the tests made:

Results of tests to determine nitrogen content in nitroglycerin filtered from various ether-soluble substances.

Substance with which nitroglycerin was mixed.	Nitrogen content of filtered nitroglycerin.	Substance with which nitroglycerin was mixed.	Nitrogen content of filtered nitroglycerin.
	Per cent.		*Per cent.*
Vaseline, refined	18.42 to 18.37	Engine oil	18.16
Vaseline, crude	18.39	Corn oil	18.35
Paraffin	18.37 to 18.42	Mononitronaphthalene	13.44
Sulphur	18.43	Mononitrotoluene (para)	14.94
Rosin (colophony)	18.07 to 18.05	Dinitrotoluene (crystals) [a]	15.60
Castor oil	18.43	Trinitrotoluene (crystals) [b]	15.43
Cottonseed oil	18.44	Resins extracted from wood pulp:	
		Sample 1	17.96
		Sample 2	17.78
		Sample 3	17.77
		Oil extracted from corn meal	18.42
		Oil extracted from wheat middlings	18.43

[a] Melting point, 66° to 68° C. [b] Melting point, 81° to 82° C.

The above results show that vaseline, paraffin, sulphur, cottonseed oil, castor oil, corn oil, and wheat oil are practically insoluble in nitroglycerin, and that the nitroglycerin mixed with them may be obtained in sufficient purity, for identification and test, by filtering through a paper filter, as the oily materials remain on the filter.

Ordinary commercial rosin (colophony), and the resinous material obtained by extracting wood pulp with ether, and engine oil, and

crystalline nitrosubstitution compounds, including mononitronaphthalene, mononitrotoluene, dinitrotoluene, and trinitrotoluene, are all soluble in nitroglycerin to an extent that vitiates the determination of nitrogen in the filtered nitroglycerin. For this reason the nitroglycerin obtained, by extraction with ether, from explosives containing wood pulp shows a slightly low figure for nitrogen content, even when the small proportion of resinous substances is removed by filtering.

DETERMINATION OF SULPHUR IN THE ETHER EXTRACT.

If an explosive contains sulphur, some of the sulphur will be found in the ether extract. However, as sulphur is only slightly soluble in ether, it is advisable to make an additional extraction with carbon bisulphide, preferably after extracting with water, in order to insure complete removal of the sulphur.

If crystals of sulphur are noted in the ether extract, the procedure is usually as follows:

The extract from which all ether has been evaporated is poured from the beaker into a dry paper filter fitted in a small funnel, and the clear liquid (generally nitroglycerin) allowed to filter through into a small weighed beaker. A convenient amount (approximately 0.7 gram) of this filtrate is used for a determination in the nitrometer to ascertain whether it is pure nitroglycerin or contains other liquid or dissolved ingredients. A nitrogen content of 18.30 per cent or more, indicating at least 99 per cent of nitroglycerin, may be considered as denoting freedom from any other liquid or dissolved material in appreciable quantities.

The nitroglycerin left in the filter is completely removed by washing with 70 per cent acetic acid, leaving the sulphur on the filter. Any sulphur in the beaker that originally contained the extract is also transferred to the filter by washing with acetic acid. The sulphur is then freed from acetic acid by washing with water, dried, and weighed. To the quantity of sulphur thus found is added the quantity found later by extraction with carbon bisulphide.

DETERMINATION OF VASELINE, PARAFFIN, OILS, AND RESINS IN THE ETHER EXTRACT.

Vaseline, paraffin, oils, and similar substances in the ether extract may be separated from the nitroglycerin by the method that is used for separating the sulphur, namely, by dissolving the nitroglycerin, nitrotoluene, etc., in acetic acid (70 per cent pure) and collecting the insoluble substances on a paper filter, from which they may be again dissolved by means of ether, the ether removed by evaporation, and the oily material weighed. The sulphur, if any, will be left on the

filter, together with the vaseline, paraffin, or oil, in which case the oily substances may be extracted from the sulphur with a small quantity of ether or petroleum ether, in both of which sulphur is only slightly soluble, the solvent evaporated, and the oily substance weighed.

Resin, if present, will be dissolved by the acetic acid used for removing the nitroglycerin and should be determined in a separate part of the ether extract by titration with a saturated solution of alcoholic potash [a] or by saponifying the nitroglycerin with alcoholic potash, acidifying, and weighing the separated resin.[b]

DETERMINATION OF NITROSUBSTITUTION COMPOUNDS IN THE PRESENCE OF NITROGLYCERIN.

A satisfactory method for the separation of nitrosubstitution compounds from nitroglycerin has been worked out in the explosives chemical laboratory of the Bureau of Mines by A. L. Hyde,[b] assistant chemist.

This method depends on the differences in solubility of nitroglycerin and nitrosubstitution compounds in carbon bisulphide and mixtures of acetic acid and water. Nitroglycerin is only slightly soluble in carbon bisulphide, but is readily soluble in mixtures of acetic acid and water, whereas most of the nitro compounds, although not readily soluble in carbon bisulphide, are more soluble in it than nitroglycerin and are less soluble than nitroglycerin in mixtures of acetic acid and water. Carbon bisulphide and mixtures of acetic acid and water are only slightly miscible. Hence nitroglycerin and a nitro compound may be partly separated by shaking the mixture with carbon bisulphide and a solution of acetic acid and water, allowing the two solvents to separate into two layers and drawing off one of the layers. The carbon-bisulphide layer will contain the greater proportion of nitrosubstitution compound and the acetic-acid layer the greater proportion of nitroglycerin.

The method devised by Hyde involves a continuous fractional separation of the ingredients of such mixtures. The following description of the apparatus and method, as in use in the explosives laboratory of the bureau, is taken from Hyde's paper.[c]

DESCRIPTION OF APPARATUS.

The apparatus consists of a series of 13 tubes for holding the 2 solvents, a circulating system made of glass tubing, a flask, which may be heated in any convenient manner, at one end of the system, a return pipe from this flask, and a measuring device, condenser, and reservoir at the other end of the system.

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, pp. 41–42.

[b] Hyde, A. L., The quantitative separation of nitrosubstitution compounds from nitroglycerin: Jour. Am. Chem. Soc., vol. 35, September, 1913, p. 1173.

[c] Hyde, A. L., loc. cit.

The whole is mounted in a wooden frame of suitable form and size, as shown in figure 6.

The tubes for holding the solvents are made in the form shown. The main shank has an inside diameter slightly less than 1 cm. and a length of about 19 cm. The top and bottom parts have an inside diameter of about 2 cm. The bottom part is about 4 cm. long, the top part about 6 cm. The top of each tube is closed with a No. 3 two-hole rubber stopper.

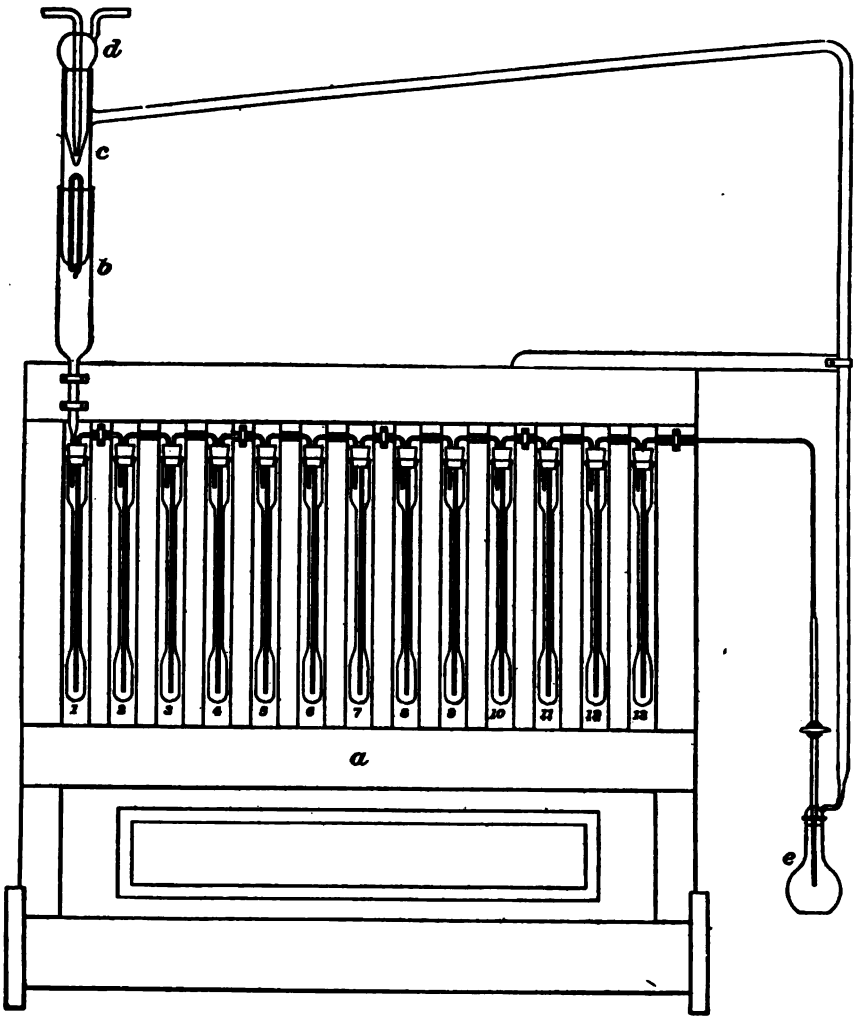

FIGURE 6.—Apparatus for separation of nitrosubstitution compounds from nitroglycerin. *a*, Support; *b*, reservoir; *c*, condenser; *d*, measuring device; *e*, collecting flask; *1* to *13*, tubes.

The circulating system consists of a series of glass tubes of a size to fit snugly the holes of the No. 3 stoppers, and bent at the top in the form of an inverted U. The long arm of each tube is long enough, when passed through the No. 3 stopper and the stopper is tightly inserted in the reaction tube, to reach almost to the bottom of the reaction tube. The short arm, about 6 cm.

long, is drawn to capillary size at the end. The long arm of each tube is passed through one hole of a rubber stopper and the short arm through a hole of the stopper next in the series so that the tubes form a continuous chain. A tube leading from the reservoir passes through the first stopper of the series, and a tube leading from the bottom of the last reaction tube to the collecting flask passes through the last stopper.

The bottom of the collecting flask is situated about 30 cm. lower than the bottom of the reaction tubes in order that a siphon may be formed to cause a continuous flow of liquid through the tubes into the flask. Just above the flask is a stopcock designed to regulate the flow through the siphon. The flask has a ground-glass stopper with two openings, one of which is connected with the return pipe to the condenser.

The condenser is provided with a siphon measuring device, holding 80 c. c., for measuring the quantity of solvent that passes through the system. This measuring device empties directly into the reservoir below. The whole circulating system is fastened in the wooden stand and remains there permanently, but the reaction tubes may be removed for cleaning and filling. When the reaction tubes are filled and in place the whole series forms an air-tight system.

OPERATION OF THE APPARATUS.

To use the apparatus, tubes *2* to *11*, inclusive, are filled up to the bottom of the shank with carbon bisulphide, and the remainder of their length with a mixture consisting of 75 per cent acetic acid and 25 per cent water. About 170 c. c. of the mixture are required for the entire apparatus. The mixture should nearly touch the stopper when the tube is placed in the system, thus allowing the capillary point of the U-tube to dip 2 or 3 cm. into the liquid. Tubes *12* and *13* are filled in the same way, but with water instead of acetic-acid mixture, and are intended to take up any small quantities of acetic acid carried along with the carbon bisulphide from the other tubes. Except for this precaution considerable acetic acid would be carried into the collecting flask and cause delay in subsequent evaporation.

After the solvent tubes are in place the mixture to be separated is dissolved in 10 to 15 c. c. of a mixture of acetic acid and water, and the solution is poured into tube *1* on top of the layer of carbon bisulphide already poured into the bottom part of the tube. When tube *1* is in place carbon bisulphide is poured into the measuring device until it runs over into the reservoir, the collecting flask is put in place, and the process is started by opening the cock just above the collecting flask. The rate of flow is regulated by means of the cock so that 3 to 4 c. c. of solvent flows into the flask per minute. The flask is heated by immersing it in a dish of hot water, which is heated by a small electric heater.

The action that takes place is as follows: Carbon bisulphide coming down through the tube from the reservoir falls in fine drops through the acetic-acid solution containing both nitroglycerin and the nitro compound, extracts some of both, and carries this over into tube *2*. Here the carbon bisulphide again falls through the acetic-acid mixture in a series of fine drops, and most of the nitroglycerin and some of the nitro compound are extracted. The same process is repeated in each reaction tube, the solvent stream being freed more and more from nitroglycerin as it progresses along the system. After a certain quantity of carbon bisulphide has passed through the system, nitro compound, entirely free from nitroglycerin, begins to appear in the stream flowing into the collecting flask. If sufficient solvent is passed through the system, prac-

tically all of the nitro compound will be carried over into the collecting flask. While the solvent is flowing into the collecting flask it is also being evaporated and passed back to the condenser to be used again. After the process is completed the flask is removed, the solution poured into a small beaker, the solvent evaporated in a bell-jar evaporator,[a] and the nitro compound weighed.

In the case of a nitro compound much more soluble in carbon bisulphide than nitroglycerin is, practically all the nitro compound will have passed into the collecting flask before traces of nitroglycerin appear there. In case, however, the difference in solubility is slight, small quantities of nitroglycerin will begin to appear in the collecting flask before all the nitro compound has come over. It is obvious that in these cases a perfectly sharp quantitative separation can not be made with a single fractionation, but even in these cases, as will be shown, it is possible to obtain satisfactory results with a single fractionation by regulating the quantity of solvent passing through the system.

It is evident that with a nitro compound whose solubility is only slightly different from that of nitroglycerin, the accuracy of the separation depends upon stopping the process after most of the nitro compound has passed over and before much nitroglycerin begins to pass over.

It was found that the passage of about 880 c. c. of carbon bisulphide through the apparatus sufficed to carry over practically all the nitro compound. Three mixtures were tested using this quantity of solvent. The results are noted below:

Results of separation of nitrotoluenes from nitroglycerin.

Mixture.	Components.	Composition of mixture.			
		Actual.		By analysis.	
		Grams.	Per cent.	Grams.	Per cent.
1	Nitroglycerin	2.623	52.7	2.595	52.2
	"Liquid trinitrotoluene"	2.353	47.3	2.381	47.8
2	Nitroglycerin	2.838	63.5	2.831	63.4
	"Liquid trinitrotoluene"	1.631	36.5	1.638	36.6
3	Nitroglycerin	3.400	78.1	3.406	78.2
	"Liquid trinitrotoluene"	.955	21.9	.949	21.8

In order to determine whether any nitroglycerin was present in the product obtained in the collecting flask, tests were made in several of the foregoing experiments. These tests showed that in no case was the separation entirely complete, but that 1 to 2 per cent of the quantity of nitroglycerin originally present had passed into the collecting flask. However, as the above results show, the accuracy is sufficient for most purposes. If in any particular case it is desired to obtain the nitro compound more nearly free from nitroglycerin than can be obtained with one separation, a second separation may be made, which will still further reduce the proportion of nitroglycerin. But this is a rather tedious process and usually should not be necessary. A double separation of one mixture was made to determine what accuracy could be expected.

The mixture contained 3.475 grams, or 58.8 per cent of nitroglycerin, and 2.434 grams, or 41.2 per cent of liquid trinitrotoluene. The nitrotoluene obtained after two separations weighed 2.388 grams, or 40.4 per cent of the original mixture. A test of the nitrotoluene separated showed that it contained less than 10 mg. of nitroglycerin.

[a] For description of evaporator see pp. 35 and 36 of this bulletin.

Additional experiments showed that certain other nitrosubstitution compounds besides the nitrotoluenes could be readily separated from nitroglycerin by this method; for example, mononitrobenzene, dinitrobenzene, and mononitronaphthalene, and, further, that various nitrosubstitution compounds may be just as readily separated from each other, the only requirement being that there shall be sufficient difference in their solubilities.

It is likely that, by slight changes in the solvents (for example, in the strength of the acetic acid), the method may be applied to the separation of any nitrosubstitution compounds from nitroglycerin or from each other, and even to the separation of oils and other ether-soluble materials from nitroglycerin, etc.

DETERMINATION OF NITROPOLYGLYCERIN IN MIXTURE WITH NITROGLYCERIN.

Some types of low-freezing explosives contain mixtures of nitroglycerin and nitropolyglycerin, the effect of the latter being to greatly reduce the freezing point of the nitroglycerin. This mixture is usually prepared as follows: Glycerin is polymerized by one of the usual methods, generally at an elevated temperature and high pressure. The resulting product is a mixture of polymerized glycerin and unaltered glycerin, varying in composition according to the length and conditions of treatment. It is probable that the polymerized glycerin contains small amounts of polymers higher than diglycerin.

This product is then nitrated in the same manner as ordinary glycerin, the nitrated material consisting of a mixture of trinitroglycerin, tetranitrodiglycerin and corresponding nitrates of whatever higher polymers may be present.

This mixture is in appearance and general properties similar to ordinary nitroglycerin, and in a hasty analysis might be mistaken for it. The best means of identifying the nitropolyglycerin are by (1) determination of nitrogen content, (2) determination of molecular weight, and (3) determination of solubility. For all of these determinations the residue left after evaporation of the ether from the ether extract should be filtered in order to remove resins, sulphur, or other substances which form a sort of scum on the surface of the liquid. A small filter paper in a small funnel can be used for the filtration and a clear liquid is easily obtained.

METHOD FOR DETERMINING THE NITROGEN CONTENT OF THE MIXTURE.

In determining the nitrogen content of a mixture of nitroglycerin and nitropolyglycerin by means of the nitrometer about 0.75 gram of the filtered ether extract is used for the determination. The nitrogen content of pure nitroglycerin being 18.5 per cent and that of

tetranitrodiglycerin 16.19 per cent, the approximate proportions of these two compounds in the mixture are readily calculated (any small content of higher polymers being disregarded).

BOILING-POINT METHOD FOR DETERMINING MOLECULAR WEIGHT OF THE MIXTURE.

For determining the molecular weight of a mixture of nitroglycerin and nitropolyglycerin the boiling-point method has been found to give satisfactory results, ethyl acetate being used as a solvent.[a]

The apparatus used for this purpose in the bureau's laboratory is a slight modification of the well-known Beckmann apparatus. The solution is heated internally by means of an electric heating coil of fine platinum wire sealed into the bottom of the tube, and in order to minimize the change in concentration of the solution a condensing coil of copper tubing is wrapped around the outside of the tube just above the surface of the solution. Circulation of cold water through this coil keeps the walls of the boiling tube cold and provides for quick condensation of the vapors of the solvent. The thermometer used is an ordinary Beckmann differential thermometer, reading to hundredths of a degree.

The method used is as follows: About 12 c. c. of pure ethyl acetate is placed in the tube, the thermometer inserted, and the solvent boiled until equilibrium is established. The boiling point is then noted and the tube is emptied and dried. A weighed quantity of the mixture to be tested (2.5 to 3 grams) is dissolved in about 10 c. c. of the ethyl acetate, the solution is then weighed and quickly transferred to the boiling-point tube. The boiling point of the solution is determined under the same conditions as that of the pure solvent; the difference in the boiling points represents the effect of the dissolved material.

Assuming that the law for dilute solutions holds also in the case of more concentrated solutions, the molecular weight of the substance is $m=\frac{gr}{a}$, where g is the weight in grams of added substance per 100 grams of solvent, a the rise in boiling point, and r the boiling-point constant of the solvent used ($r=26.1$ for ethyl acetate[b]).

It has been shown by Hyde[c] that excellent results may be obtained with this method if ethyl acetate be used as the solvent, but that results with ether, acetone, methyl alcohol, and chloroform are not concordant and vary rather widely with the concentration of the solution. Many determinations on pure nitroglycerin by this method have given for the molecular weight values ranging from 229 to 235. The theoretical molecular weight is 227.

[a] Hyde, A. L., Boiling points of solutions of nitroglycerin: Original Communications, 8th Int. Cong. App. Chem., vol. 4, 1912, p. 59.
[b] Biedemann, R., Chemiker Kalender, 1910, vol. 2, p. 49.
[c] Hyde, A. L., loc. cit.

THE TWO METHODS COMPARED.

In order to test the value of this method in comparison with the nitrometer method, a sample of partly polymerized glycerin was nitrated and washed free from acid. The resulting mixture of nitroglycerin and nitropolyglycerin was found by test in the nitrometer to contain 16.85 to 16.88 per cent of nitrogen. Assuming the mixture to consist of nitroglycerin (18.50 per cent nitrogen) and tetranitrodiglycerin (16.19 per cent nitrogen), the nitrogen content of the mixture corresponds to that of a mixture containing 29.23 per cent nitroglycerin and 70.77 per cent tetranitrodiglycerin. Such a mixture would have a molecular weight (calculated) of 311. The molecular-weight determination made as above described gave results of 306 and 314, an average of 310.

A second sample of partly polymerized glycerin was nitrated in a similar manner and the nitrated product tested, with the following results:

The nitrogen content was 16.58 to 16.63 (average 16.605) per cent, corresponding to a mixture consisting of 17.75 per cent nitroglycerin and 82.25 per cent tetranitrodiglycerin. The calculated molecular weight of this mixture is 325; the molecular weight as determined was 325 and 328, the average being 326.5.

In both tests the results of the determinations of nitrogen and molecular weight agree very closely.

METHOD FOR DETERMINING SOLUBILITY OF THE MIXTURE.

The difference in solubility of nitroglycerin and nitropolyglycerin in dilute acetic acid (60 volumes of glacial acetic acid to 40 volumes of water) provides a convenient means of identifying nitropolyglycerin in such a mixture.

Experiments have shown that 1 gram of nitroglycerin will completely dissolve in approximately 10.5 c. c. of dilute acetic acid of the concentration mentioned—the specific gravity of such a mixture is approximately 1.069 at 15° C.—whereas nitropolyglycerin is much less soluble. One gram of the mixture of nitroglycerin and nitropolyglycerin previously mentioned containing 82.25 per cent tetranitrodiglycerin required 120 c. c. of the acetic-acid solution to completely dissolve it. In treating this sample with the acetic acid, adding the acid in small quantities and shaking thoroughly after each addition, it was found that when about 50 c. c. had been added only a small quantity of the mixture remained undissolved, and this small quantity required about 70 c. c. more acid for complete solution, the volume of the undissolved part decreasing slightly with each addition of 10 c. c. of acid.

Although no definite conclusions as to the presence of nitropolyglycerin should be made from the results of any one of the three

tests described, it is apparent that the data supplied by all three tests when combined is sufficient to determine whether there is any nitropolyglycerin in the ether extract.

This point may be illustrated by the following description of an actual analysis. The ether extract from an ammonium-nitrate explosive was an oily liquid with the appearance of nitroglycerin. A filtered part of this extract was found by the nitrometer to contain only 17.7 per cent nitrogen. A molecular-weight determination on another part gave a result of 265, indicating a mixture with a molecular weight greater than that of nitroglycerin. About 5 grams of the extract was shaken with 150 c. c. of 60 per cent acetic acid (nearly three times the amount necessary to dissolve 5 grams of pure nitroglycerin). The insoluble part was separated, washed, dried, and its nitrogen content, determined in the nitrometer, was 16.24 per cent, which is almost the theoretical nitrogen content (16.19 per cent) of tetranitrodiglycerin.

If the extract is composed of nitroglycerin and tetranitrodiglycerin, the nitrogen content of 17.7 per cent indicates a mixture consisting of 65.4 per cent nitroglycerin and 34.6 per cent tetranitrodiglycerin, whereas the molecular weight 265 indicates a mixture containing 68 per cent nitroglycerin and 32 per cent tetranitrodiglycerin. It is therefore safe to assume that the extract consists of approximately 2 parts of nitroglycerin to 1 part of tetranitrodiglycerin.

EXTRACTION WITH WATER.

METHOD OF EXTRACTING WATER-SOLUBLE INGREDIENTS.

In practically all types of permissible explosives the extraction with water is carried out on the dried and weighed residues left in the extraction crucibles after extracting with ether. The method employed is the same as in the treatment of ordinary dynamites.[a] The Gooch crucible is inserted in the top of a carbon filter tube, which is fitted with a short length of thin-walled rubber tubing to make a tight joint between the crucible and the filter tube. The lower end of the filter tube is passed through a rubber stopper in the mouth of a side-neck suction flask. About 200 c. c. of cold distilled water is then passed through the sample in each crucible in quantities of about 20 c. c. each, each addition of water being allowed to stand in the crucible for a short time before it is drawn into the flask. The necessary suction is obtained from an ordinary filter pump operated by water pressure. A few drops of the last addition of water passed through the sample are tested by evaporation on a glass plate to insure that all water-soluble material has been dissolved.

[a] See Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, p. 43.

If the qualitative analysis of the explosive has indicated that it contains a considerable proportion of starch, the extractions will be facilitated by the use of porous alundum filtering crucibles in place of the ordinary porcelain Gooch crucibles, as the porous crucibles permit the water solution to filter through the walls of the crucible above the dense layer of starch which will separate out in the bottom of the crucible. With porous crucibles, however, it has been found advisable to use the Spencer glass funnel,[a] which provides for a tight joint between the top of the crucible and the walls of the funnel by means of a soft rubber ring resting on top of the crucible. By means of this apparatus the absorption of water-soluble salts in the upper part of the wall of the crucible is avoided, as the crucible may be entirely filled with each addition of water, completely removing all soluble material. Perfect washing of the upper part of the porous crucibles is practically impossible when the ordinary carbon filter tubes are used.

Another device which has been found to insure complete removal of the water-soluble material from the porous crucibles is the so-called "filtering crucible holder," which enables the porous crucible to be used with any ordinary 60-degree funnel. The holder consists of a hard-rubber device with a soft flange forming tight joints with the walls of the funnel on one side and with the extreme top of the crucible walls on the other side. Both of the above devices are used in the explosives laboratory of the Bureau of Mines and give satisfactory results.

The water extracts are transferred from the suction flasks, diluted with distilled water to a known volume, usually 250 c. c. each, and reserved in stoppered bottles for quantitative determination of the dissolved ingredients.

DRYING OF INSOLUBLE RESIDUE.

The crucibles, after the contents have been subjected to extraction with water, are placed in a drying oven and the residue dried to constant weight. About five hours' drying at a temperature of 95° to 100° C. is usually necessary for thorough drying of the residue, especially if it contains wood pulp, cereal products, or other organic materials, and it is often convenient to continue the drying for a longer period, for example, overnight. Upon removal from the oven the crucibles with their contents are placed in a tight desiccator, preferably over sulphuric acid, and weighed as soon as they have cooled to room temperature, about 15 to 20 minutes being sufficient for cooling.

[a] Spencer, G. L., Alundum crucibles in gravimetric analyses: Jour. Ind. Eng. Chem., vol. 4, 1912, p. 614.

The loss of weight noted represents the total amount of water-soluble material, including, in addition to all water-soluble salts and soluble organic ingredients, small quantities of substances extracted from the wood pulp, cereal products, or other carbonaceous absorbents.

EXAMINATION OF WATER EXTRACT.

It has been noted in the table of possible components shown on page 13 that the water extract of a low-flame explosive may contain a great variety of constituents, and attention has been called on page 17 to the difficulties often involved in definitely determining the manner in which the various bases and acid radicles were actually combined in the original explosive.

When qualitative tests have been obtained for several water-soluble ingredients, the method of mechanical examination (p. 17) or that of specific-gravity separation (p. 18) may give information as to exactly what combination of salts is present, so that the results of the separate determinations of bases and acid radicles may be properly interpreted.

The analysis of the water solution may involve many determinations which can be carried out by well-known methods described in reliable textbooks on quantitative analysis, such as the determination of chloride by precipitation as AgCl, of sulphate by precipitation as $BaSO_4$, of oxalate by precipitation as CaC_2O_4 and ignition to CaO, of carbonate by titration or evolution methods, or of potassium, magnesium, calcium, barium, zinc, and aluminum, by well-known gravimetric methods. These usual methods are employed in the bureau's laboratory, but are not discussed in this bulletin except where it is desired to emphasize some important feature.

It is customary to determine each constituent on a separate aliquot part of the water extract; usually 50 c. c. is taken for each determination. Duplicate analyses are made on parts of the two solutions representing the water extracts of the duplicate samples of the explosives.

DETERMINATION OF NONVOLATILE SOLIDS.

Aliquot 50 c. c. portions of the water extracts are evaporated to dryness in weighed platinum dishes on a steam bath, after about 1 or 2 c. c. of nitric acid has been added. If the solution contains sulphates, sulphuric acid is added instead of nitric. Also, if more than a small amount of chlorides is present, the evaporation with nitric acid should be carried out not in platinum dishes but in porcelain or silica dishes, because of the fact that chlorine liberated by the action of the nitric acid on chlorides will attack the platinum.

Dishes of pure fused silica ("Vitreosil" or other commercial product), about 3½ inches in diameter, weighing 25 to 30 grams, are largely used in the bureau's laboratory and give satisfactory results.

IGNITION OF RESIDUE.

The residue from the evaporation is heated gently over a burner to volatilize ammonium salts and free acid, and burn off soluble organic matter. If the explosive contains organic materials such as wood pulp or cereal products, an appreciable quantity of soluble organic material will be found in the water solution. Experiments in the bureau's laboratory have shown that extraction with cold water may remove as much as 2 to 3 per cent from corn meal, 10 to 15 per cent from wheat flour (middlings), and 2 to 3 per cent from wood pulp. The water extract, therefore, may contain an amount, which depends on the proportion of carbonaceous material in the explosive, of dissolved organic material varying from a few tenths of 1 per cent to as much as 2 or 3 per cent, and also such soluble organic materials as are actual ingredients of the explosive.

After gentle ignition the residue is again treated with a small quantity of dilute acid, evaporated to dryness, and gently ignited until fuming ceases, or heated in an oven at about 120° C.

TREATMENT OF RESIDUE CONTAINING ZINC.

If the original sample of explosive contained ammonium nitrate and zinc oxide, the zinc oxide will have been mostly dissolved in the water solution by the action of the ammonium nitrate, and, in case nitric acid has been added to the water solution, the zinc will be present as zinc nitrate in the residue left on evaporation. The zinc nitrate is readily converted by ignition to zinc oxide, and on heating the residue strongly an evolution of oxides of nitrogen accompanied by an appreciable bubbling of the fused residue is noted. This bubbling may occasion loss of the fused solids unless the heating is done with great care. It is therefore advisable not to attempt to convert the zinc nitrate to zinc oxide by ignition, but to leave it as zinc nitrate, by heating the residue just to its fusion point only, or heating it in an oven at about 120° C. for one hour. Either method will completely remove the free acid and leave the residue in the form of nitrates.

If sulphuric acid, instead of nitric acid, has been added to the water solution during evaporation, the evaporated residue will, on heating until fumes are no longer given off, remain as sulphates.

This treatment with acid, evaporation, and ignition or drying is repeated until the weight of residue is practically constant. The residue represents the total quantity of nonvolatile inorganic salts

in the water solution, in the form of nitrates or sulphates, depending on the method followed.

The value of this determination is obvious. For example, if the solution contained sodium nitrate, ammonium nitrate, zinc oxide, and sodium sulphate, the nonvolatile residue would contain Na_2SO_4 and $ZnSO_4$. The use of the specific-gravity separation in the preliminary qualitative examination (p. 18) would easily have indicated the presence of sodium sulphate and sodium nitrate. The Na_2SO_4 is determined gravimetrically as $BaSO_4$ in an aliquot part of the water extract. The nonvolatile residue obtained by evaporation of the water extract is redissolved, the zinc determined by precipitation as $ZnCO_3$ and ignition to ZnO, and this weight of ZnO calculated to an equivalent weight of $ZnSO_4$. The weight of Na_2SO_4 found plus the weight of $ZnSO_4$ is then deducted from the total weight of residue found by evaporation as sulphates, the difference being equal to the $NaNO_3$ content in terms of Na_2SO_4. The equivalent amount of $NaNO_3$ is then readily calculated. The NH_4NO_3 in the water extract is then determined by using another aliquot portion of the solution, and should be approximately equal to the total weight of water-soluble material minus the sum of the Na_2SO_4, $NaNO_3$, and ZnO contents, unless the extract contains an appreciable amount of soluble organic material.

DETERMINATION OF AMMONIUM SALTS AS NH_3.

Ammonium salts are determined by the well-known method of distillation. An excess of strong KOH solution is added to an aliquot part of the water extract in a Kjeldahl or other distillation flask, the NH_3 is distilled into a known volume of standard H_2SO_4 solution, and the excess of acid titrated with standard alkaline solution, cochineal being used as the indicator. This method has been previously described in Bulletin 51.[a]

DETERMINATION OF ZINC.

As has been previously stated, when an explosive contains both zinc oxide and ammonium nitrate the zinc will be found mostly in the water extract, due to the solubility of the zinc oxide in ammonium nitrate.

The residue obtained by evaporation of the water extract is redissolved in dilute HCl, and the zinc precipitated as $ZnCO_3$ by carefully adding Na_2CO_3 until a slight turbidity shows on stirring. The mixture is then heated to boiling and filtered while hot through a Gooch crucible. If the solution is not alkaline after boiling, as may be

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, pp. 58–59.

readily determined by adding a few drops of phenolphthalein solution, more Na_2CO_3 is added until the red color of the indicator persists. The $ZnCO_3$ in the Gooch crucible is then ignited to ZnO and weighed.

Other alternative methods for determining zinc have been described in Bulletin 51,[a] but the above method has been found entirely satisfactory.

DETERMINATION OF POTASSIUM.

PERCHLORATE METHOD.

Potassium is determined by the well-known method of precipitation with platinic chloride or by the perchlorate method of Sérullas.[b] The perchlorate method depends upon the fact that potassium perchlorate is practically insoluble in alcohol, whereas the perchlorates of the other bases which might be present are more or less readily dissolved by this solvent.

The water solution containing potassium salts must be free from sulphuric acid or sulphates; if it does contain them they can be removed by precipitation with $BaCl_2$ and filtration. The solution is then evaporated to dryness and all acid fumes and ammonium salts driven off. The residue is dissolved in 50 c. c. of hot water containing considerably more than enough perchloric acid to combine with all the bases. Usually 5 to 6 c. c. of perchloric acid solution of 1.12 specific gravity is sufficient. This solution is obtainable from chemical dealers or may be prepared in the laboratory.[c] Evaporate the mixture until it is thick, add a little more hot water and 5 to 6 c. c. more of the perchloric acid, and continue the evaporation, with stirring. Then heat the residue on a sand bath until dense white fumes are evolved. The cooled residue is then stirred with 20 c. c. of 97 per cent alcohol containing 0.2 per cent by weight of perchloric acid, and transferred to a Gooch crucible, using 20 c. c. more of the same alcohol solution. The residue of potassium perchlorate in the Gooch crucible is then washed with about 20 c. c. of a mixture of equal volumes of ether and alcohol, dried at 120 to 130° C., and weighed.

The barium perchlorate is readily soluble in the alcohol used, and magnesium does not interfere if the excess of perchloric acid is large enough. Ammonium salts should be removed, as has been stated, because ammonium perchlorate is not readily soluble in alcohol.

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[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, p. 58.

[b] Sérullas, —, Crystallisation de l'acide oxichlorique (perchlorique), et sur quelques proprietés nouvelles de cet acide: Ann. chim. phys., t. 46, 1831, p. 294; see also Wiley, H. W., Principles and practice of agricultural analysis, vol. 2, 1908, pp. 578–593.

[c] See Willard, H. H., Preparation of perchloric acid: Jour. Am. Chem. Soc., vol. 34, 1912, pp. 1480–1485; and Kreider, D. A., The preparation of perchloric acid and its application to the determination of potassium: Am. Jour. Sci., ser. 3, vol. 49, 1895, p. 443.

The method has been employed in the bureau's laboratory with good results and is more convenient than the platinic chloride method.

The following results are given as an example of the accuracy of the method and to show that the presence of sodium nitrate does not interfere with the determination of the potassium salt.

Results of determination of potassium nitrate in presence of sodium nitrate by perchlorate method.

Weight of KNO_3 and $NaNO_3$ used.		Weight of $KClO_4$ obtained.	Weight of KNO_3 found.	Error of determination.
KNO_3.	$NaNO_3$.			
Gram.	*Gram.*	*Gram.*	*Gram.*	*Gram.*
0.2500	0.2500	0.3414	0.2491	−0.0009
.2500	.2500	.3420	.2495	−.0005

DETERMINATION OF NITRATES BY NITROMETER METHOD.

Nitrates in the water solution may be determined by means of the nitrometer as described in Bulletin 51.[a] An aliquot part of the water solution, containing not more than the nitrogen equivalent of 0.8 gram of $NaNO_3$ or 1 gram of KNO_3, is evaporated nearly to dryness on the steam bath and completely transferred, by means of as little water as possible, to the nitrometer generating bulb. Then 30 to 40 c. c. of 95 to 96 per cent H_2SO_4 is added slowly in small quantities to avoid overheating, and the generator shaken 8 to 10 minutes, when the volume of gas (NO) is measured and the percentage of nitrate calculated. It is necessary to use a larger volume of H_2SO_4 and to shake longer than is required in the determination of nitroglycerin because of the dilution of the acid by the water used for transferring the sample from the dish to the generator. The method gives accurate results if care is taken to insure that the reaction in the nitrometer is complete, by shaking for a sufficient length of time.

DETERMINATION OF NITRATES BY NITRON METHOD.

The determination of nitrates by the "nitron" method of Busch[b] has been described in a number of textbooks[c] but has not found general use in technical laboratories. It gives very reliable results when carried out with proper care and is here described in detail.

"Nitron," or 1:4 diphenyl 3:5 endoanilodihydrotriazol ($C_{20}H_{16}N_4$), forms an addition product with one molecule of HNO_3 which is only slightly soluble in cold water.

[a] Snelling, W. O., and Storm, C. G., The analysis of black powder and dynamite: Bull. 51, Bureau of Mines, 1913, p. 45.

[b] Busch, M., Gravimetrische Bestimmung der Salpetersäure: Ber. deut. chem. Gesell., Jahrg. 38, 1905, p. 861; Gutbier, A., Die gewichtsanalytische Bestimmung der Salpetersäure mittels "Nitron" nach M. Busch: Ztschr. angew. Chem., Jahrg. 18, 1905, p. 494; Hes A., Über die gewichtsanalytische Bestimmung der Salpetersäure: Ztschr. anal. Chem., Jahrg. 48, 1909, p. 81.

[c] Escales, R., Die Schiessbaumwolle, 1905, p. 218; Lunge, G., and Berl, E., Chemisch-technische Untersuchungsmethoden, Bd. 1, 1910, p. 391.

PREPARATION OF REAGENT.

To prepare the reagent, 1 part of nitron is dissolved in 9 parts of 5 per cent acetic acid with the aid of heat, filtered, and placed in a dark bottle. The solution decomposes in the light and does not keep well, hence it is best to prepare it in small quantities as needed.

METHOD OF PROCEDURE.

To the solution of nitrate, containing preferably not over 0.10 to 0.15 gram of nitrate, diluted to about 80 c. c., add 12 to 15 drops of dilute H_2SO_4, heat to the boiling point, add 12 to 15 c. c. of the nitron reagent, stir and let stand one-half to three-fourths hour. Long, silky, needlelike crystals of the nitron nitrate separate out on cooling. Place the beaker in ice water for one to two hours and then filter off the crystals in a Gooch crucible, using slight suction. Wash with 10 c. c. of water cooled to 0° C., and added in quantities of 1 to 2 c. c. at a time, using a part of the filtrate for washing out the beaker. Dry the precipitate at 105° to 110° C. until constant weight is obtained; about one hour is usually sufficient. To insure complete precipitation the filtrate is heated to boiling, a little more of the reagent added, and the mixture cooled as before.

The molecular weight of nitron is 312, of nitron nitrate 375. Thus, the nitrate being six times as heavy as HNO_3, an error in the weight of the precipitate is reduced to one-sixth when expressed as HNO_3 or to one-twenty-seventh when expressed as N.

The equation for converting the weight of nitron nitrate to the equivalent weight of sodium nitrate is as follows:

$$\frac{\text{Weight of nitron nitrate} \times 85}{375} = \text{Weight of sodium nitrate.}$$

INTERFERENCE OF OTHER SALTS.

Busch[a] states that moderate amounts of chlorides or sulphates do not interfere with the determination of nitrate, but that bromides (solubility 1:800), iodides (1:20,000), chromates (1:6,000), chlorates (1:4,000), and perchlorates (1:50,000) are precipitated by the nitron reagent.

SOLUBILITY OF NITRON NITRATE.

Collins[b] found that 0.45 per cent of the nitron-nitrate precipitate dissolved in 10 c. c. of ice water. The writer has found that if the weighed precipitate from 0.15 gram of KNO_3 is treated in the Gooch crucible with 10 c. c. of ice water in the same manner as in washing,

[a] Busch, M., loc. cit.

[b] Collins, S. W., The "nitron" method for the estimation of nitric acid: Analyst, vol. 32, 1907, p. 349.

an average loss of 0.61 per cent results. This agreed closely with the average result of 99.4 per cent obtained in determinations of pure KNO_3.

RECOVERY OF NITRON.

The excess nitron in the filtrates and washings and the nitron contained in the precipitated nitron nitrate may be recovered as follows: The filtrates and washings are made slightly alkaline with NH_4OH and the precipitated nitron filtered and washed with water. The nitron-nitrate precipitate is added to dilute NH_4OH, warmed to 60° C., the precipitated nitron quickly filtered under slight pressure, washed with cold water, and dried in a vacuum. Decomposition may be avoided by conducting the filtering and washing in an atmosphere of inert gas and as much as possible away from the light.

DETERMINATION OF CHLORATES.

Two methods for the determination of chlorates are employed in the bureau's explosives laboratory, both giving excellent results and offering numerous advantages over many of the more laborious methods described in the literature and in the textbooks.

DETERMINATION OF CHLORATE BY REDUCTION WITH SULPHUR DIOXIDE.

Sulphur dioxide readily reduces chlorate to chloride in water solution. Its use in quantitatively determining chlorate is briefly mentioned by Gody,[a] but no reference to it has been found by the writer in any textbook on analytical methods.

The method is as follows: An aliquot part of the water extract of an explosive, preferably containing not more than about 0.50 gram of chlorate, is treated with a current of gaseous sulphur dioxide—which may be conveniently obtained from small cylinders of liquid sulphur dioxide, from which the current of gas can easily be regulated by means of a valve—until a strong odor of the gas persists in the solution after stopping the current and blowing across the surface of the liquid. The reduction of the chlorate is accompanied by a slight rise in temperature of the liquid, a strong solution of chlorate becoming quite warm if the sulphur-dioxide current is rapid. After complete saturation with sulphur dioxide the liquid is boiled to remove any excess of it. It is advisable, even when its odor is no longer noted, to insure its complete removal by adding a few cubic centimeters of hydrogen-peroxide solution, which oxidizes the last traces of SO_2 to H_2SO_4. The solution is then treated with a few drops of nitric acid and the chloride resulting from reduction of the chlorate is determined in the usual manner by precipitation with

[a] Gody, L., Traite theorique et pratique des matières explosives, 1907, p. 245.

silver nitrate, and weighing as AgCl. The accuracy of the method is shown by the following results on weighed quantities of pure potassium chlorate.

Results of determinations of pure potassium chlorate by SO_2-reduction method.

Test No.	Weight of $KClO_3$ used.	Weight of AgCl found.	$KClO_3$ found.	
			Weight.	Proportion of original quantity.
	Gram.	*Gram.*	*Gram.*	*Per cent.*
1	0.2500	0.2917	0.2494	99.76
2	.2500	.2918	.2495	99.80
3	.2500	.2915	.2492	99.68
4	.2500	.2919	.2496	99.84
Average				99.71

It must be noted that the complete removal of the sulphur dioxide from the solution is necessary in order to avoid reduction of the silver nitrate.

DETERMINATION OF CHLORATE BY REDUCTION WITH FORMALDEHYDE.

Formaldehyde in the form of the commercial solution called "formalin," containing approximately 40 per cent of gaseous formaldehyde, is also an effective and convenient reducing agent for quantitatively converting chlorate to chloride. Grützner[a] called attention to the reduction of potassium chlorate by means of formaldehyde, and noted that the method might be employed for the quantitative determination of chlorates. The same reaction was discovered independently by the writer in 1911 and developed into an exact quantitative method for determining chlorates before the reference to Grützner's method had been noted. The results of the investigation of this method will be published as a separate paper, but the following brief description of the method will serve to indicate its application in the determination of chlorates in explosive mixtures.

A part of the water extract of the explosive, containing about 0.5 gram of chlorate, is diluted to about 150 c. c. and treated with 5 to 10 c. c. of a 40 per cent solution of formaldehyde, 2 c. c. of dilute nitric acid (1:3), and 50 c. c. of approximately $\frac{N}{10}$ silver nitrate solution. The beaker containing the mixture is covered with a watch glass and heated on the steam bath for 3½ to 4 hours, after which the precipitated silver chloride may be at once filtered off, washed, dried, and weighed. The period of heating on the steam bath may be

[a] Grützner, B., Ueber Formaldehyd als Reduktionsmittel und über eine neue quantitative massanalytische Bestimmung desselben. (A volumetric or gravimetric method for the determination of formaldehyde): Arch. Pharm., Bd. 234, 1896, p. 634; Ztschr. anal. Chem., Jahrg. 36, 1897, p. 527.

shortened to 2 hours if the mixture is afterwards allowed to stand overnight before filtering. Boiling the solution causes loss of some chlorine compound and makes the results low.

The following tabulation of a few results taken at random from a large number of tests made as described above shows that the method gives remarkably accurate results.

Results of determinations of pure potassium chlorate by the formaldehyde reduction method.

Test No.	Weight of $KClO_3$ used.	Weight of AgCl found.	$KClO_3$ found.	
			Weight.	Proportion of original quantity.
	Gram.	*Gram.*	*Gram.*	*Per cent.*
1	0.5002	0.5855	0.5006	100.08
2	.5003	.5850	.5002	99.98
3	.5002	.5841	.4994	99.84
4	.5004	.5850	.5002	99.95
5	.5002	.5848	.5000	99.96
6	.5000	.5840	.4993	99.86
7	.5003	.5850	.5002	99.98
Average				99.95

DETERMINATION OF PERCHLORATES.

Several methods for the determination of perchlorates have been investigated in the explosives laboratory of the bureau, and the fusion method and the nitron method have been selected as the most convenient and satisfactory.

FUSION METHOD.

The fusion method consists in converting the perchlorate to chloride by fusion with anhydrous sodium carbonate and determining the resulting chloride by the usual method of precipitation as silver chloride.[a]

To determine the perchlorate in a water solution, an aliquot part of the solution is evaporated to a small volume and completely transferred to a 25-c. c. platinum crucible, where evaporation is continued until the volume is about 5 c. c. Anhydrous sodium carbonate is then added to the solution in the crucible until the crucible is completely full of the powder. The small amount of solution is absorbed by the sodium carbonate, and is readily dried out by careful heating with a small flame or on a steam bath or hot plate, after which the mass is heated over a burner until no evolution of gas bubbles is noted. The time of fusion is usually 15 to 20 minutes. The melt is then cooled, dissolved in dilute nitric acid, and the chloride determined by precipitation with silver nitrate.

[a] Förster, O., Mittheilungen aus der analytischen Praxis; Bestimmung von Perchlorat in Chilisalpeter: Chem. Ztg., Jahrg. 22, 1898, p. 357.

If both chloride and chlorate are present in addition to perchlorate, this determination gives the sum of all three of these ingredients weighed as silver chloride. A separate determination of chlorate by one of the methods described on pages 62 and 63 gives the chlorate and chloride together as chlorides, and a further separate determination is made of the chloride content in the original solution. From these results the amount of perchlorate actually present is readily calculated.

NITRON METHOD FOR DETERMINATION OF PERCHLORATES.

It has been noted (p. 61) that perchlorates are precipitated by nitron, and therefore interfere with the determination of nitrates by the nitron method when both nitrates and perchlorates are contained in the same solution. The extraordinarily low solubility of nitron perchlorate (according to Busch,[a] 1:50,000) suggested the use of the nitron method for determining perchlorates, and a limited number of trials has justified the conclusion that perchlorates, in the absence of interfering salts, such as nitrates, chlorates, bromides, iodides, chromates, and picrates, may be accurately determined by precipitation as nitron perchlorate.

The determinations were carried out by exactly the same method as has been described in pages 60 to 62 for determining nitrates, about 0.12 gram of supposedly pure ammonium perchlorate being used for each test. The weight of nitron perchlorate ($C_{20}H_{16}N_4 . HClO_4$) found, multiplied by the molecular weight of ammonium perchlorate (117.5) and divided by the molecular weight of nitron perchlorate (412.5), is equal to the weight of ammonium perchlorate. Two determinations showed the ammonium perchlorate to have a purity of 99.67 and 99.58 per cent, respectively, whereas several determinations by the fusion method (p. 64) gave a purity of 99.53 per cent.

DETERMINATION OF NITRATES, CHLORIDES, CHLORATES, AND PERCHLORATES IN A MIXTURE.

A water extract containing nitrates, chlorides, chlorates, and perchlorates may be analyzed by proper application of the methods described in the preceding pages of this bulletin.

Chlorides are determined gravimetrically or volumetrically by precipitation with $AgNO_3$. Chlorates are determined by reduction with SO_2 gas (see p. 62) or formaldehyde (see p. 63) and precipitation of the resulting chloride with $AgNO_3$, the result being corrected for the chloride originally present as such.

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[a] Busch, M., Gravimetrische Bestimmung der Salpetersäure: Ber. deut. Chem. Gesell., Jahrg. 38, 1905, p. 861.

Perchlorates are determined by fusing with Na_2CO_3 and precipitation with $AgNO_3$ (see p. 64), the total chloride thus formed being corrected for the quantity originally present plus the quantity equivalent to the chlorate originally present. Nitrates are determined by reducing the chlorate to chloride with SO_2 gas, boiling off the free SO_2, precipitating the combined nitrate and perchlorate with nitron (see pp. 60 and 65), and correcting the total weight of nitron nitrate and nitron perchlorate for the weight of nitron perchlorate equivalent to the perchlorate found by the fusion method.

Obviously, each of these determinations must be made on a separate part of the water solution.

DETERMINATION OF SOLUBLE ORGANIC MATERIALS IN THE WATER EXTRACT.

In addition to those organic substances extracted from the carbonaceous combustible material which have been mentioned, such soluble organic substances as sugars and gums may be contained in the water extract as actual constituents of the explosive mixture.

DETERMINATION OF SUGARS.

The total sugars present are determined as follows: An aliquot part of the water extract is acidified with HCl (1 c. c. of strong HCl to 100 c. c. of solution), heated gradually just to the boiling point in order to invert cane sugar, and then cooled. The acidity is nearly neutralized with Na_2CO_3, an excess of Fehling's solution added, and the mixture heated on the steam bath until reduction is complete. An excess of Fehling's solution is indicated by the blue color of the supernatant liquid after the precipitate has settled. The precipitated Cu_2O is filtered off in a Gooch crucible, dried, ignited to constant weight, and weighed as CuO, or merely dried and weighed as Cu_2O.

A blank determination is made by heating an equal volume of Fehling's solution as in the determination of the sugar, filtering off any separated Cu_2O, igniting to CuO, and weighing. This weight of CuO is deducted from that obtained in the determination of the sugar. The weight of CuO multiplied by the factor 0.4308 equals the weight of cane sugar, and the corresponding factor for Cu_2O is 0.4790.[a]

In order to determine the amount of sugar in the water extract which might result from cereal products in the explosive, samples of corn meal, wheat flour (middlings), and wood pulp were extracted, first with ether to remove oils, then with cold water, and the total sugars in the water extracts determined. The amounts of sugars found were: In corn meal 2.65 per cent, in wheat middlings 6.25 to 7 per cent, in wood pulp 0.17 to 0.62 per cent. Thus if an explosive contained 25

[a] Allen, A. H., Commercial organic analysis, vol. 1, 1905, p. 284.

per cent of wheat middlings, its water extract might show a sugar content of as much as 1.75 per cent, derived from extraction of the middlings and not present as an actual constituent of the explosive.

DETERMINATION OF GUM ARABIC.

Gum arabic is used in certain granular explosives as a binding material for the purpose of agglomerating the various constituents of the explosive into more or less regular granules. The gum arabic, being entirely soluble in water, is found in the water extract and may be determined with approximate accuracy by precipitation with basic lead acetate. The precipitate formed is white, flocculent, and bulky.

Because of the fact that its composition is not definite, it is necessary to make use of a factor obtained from the results of precipitating a known weight of gum arabic from its water solution by the method employed in making the determination on an unknown solution.

The following method of procedure has been found to give satisfactory results:

A solution of basic lead acetate is prepared by adding 150 grams of normal lead acetate and 50 grams of lead oxide (PbO) to 500 c. c. of distilled water, heating the mixture almost to boiling, and filtering. Then 0.10 gram of powdered gum arabic is dissolved in cold water and basic lead acetate solution is added with stirring until no further precipitation results; the mixture is then allowed to stand for several hours, the precipitate filtered into a weighed Gooch crucible, washed several times with absolute alcohol, dried at 100° C., and weighed. Several determinations gave an average of 0.2012 gram of the precipitate from 0.10 gram of gum arabic. The factor for calculating the weight of gum arabic from the weight of the precipitate is therefore $\frac{0.1000}{0.2012}=0.4971$.

The determination of the gum arabic in a solution is carried out in exactly the above manner. The weight of precipitate multiplied by the factor 0.4971 gives the weight of the gum arabic content.

Most of the usual water-soluble constituents of explosives do not interfere with the determination of gum arabic. Any chlorides must, however, be removed by precipitation with silver nitrate, as the precipitation of lead chloride in the cold solution would cause high results.

EXTRACTION WITH DILUTE HYDROCHLORIC ACID.

The principal substances soluble in cold dilute hydrochloric acid are the antacids added to the explosive to neutralize any acidity that may be present or might later develop in some constituent of the

explosive. The antacids generally used are calcium or magnesium carbonates or zinc oxide; the zinc oxide is usually found in the water solution if the explosive contains NH_4NO_3. Other substances, more or less soluble in dilute hydrochloric acid, that may form part of the explosive are metallic zinc, aluminum, manganese dioxide, and ferric oxide. A sample of a commercial explosive, recently examined in the bureau's laboratory, contained calcium silicide.

Extraction with cold dilute hydrochloric acid is resorted to only when the explosive contains no starch. When the explosive contains cereal products this cold acid treatment is dispensed with and the acid-soluble inorganic substances are removed with the starch in one operation by hydrolysis with boiling dilute acid.

EXTRACTION WITH COLD DILUTE ACID.

The extraction with cold acid is carried out in the same manner as the water extraction, using the suction flask fitted with rubber stopper and carbon tube, Spencer funnel, or other device for holding the filtering crucible. The crucibles containing the dried and weighed residues left after extraction with water are placed in the carbon tubes or other holders, and dilute hydrochloric acid (1:10) added. After standing for a short time this acid is drawn through into the flask by means of suction, and a fresh portion of the acid added. This treatment is continued until 100 c. c. of the 1:10 acid has passed through the sample in each crucible. The excess of acid is then removed from the samples with several washings of water, and the crucibles containing the insoluble residue dried as before for at least 5 hours at 95° to 100° C. and weighed at once after cooling in a desiccator.

HYDROLYSIS WITH BOILING DILUTE HYDROCHLORIC ACID.

If the explosive contains starch the extraction with cold acid is usually omitted and the hydrolysis of the starch carried out as follows:

The water-insoluble residues in the crucibles are moistened with a little water and completely transferred by means of a spatula, or with a stream of water from a wash bottle, to 500 c. c. beakers. If Gooch crucibles are used, the asbestos mats are removed together with the residues and the crucibles are dried and weighed. The weight of asbestos thus determined by difference from the original weights of the prepared crucibles is deducted from the final weight of dry residue remaining after hydrolysis. Water is added to the beakers until the total volume is about 300 c. c., then about 3 c. c. of strong hydrochloric acid (specific gravity 1.2) is added and the mixture

boiled until the starch is completely hydrolyzed, a drop of the solution being tested from time to time on a spot plate with a solution of iodine in potassium iodide until a blue coloration no longer appears.

The insoluble residue is then filtered onto a fresh Gooch crucible or through the original porous crucible, if such was used, washed with water to remove all free acid and dissolved material, dried as before, and weighed, the weight being corrected for the weight of the asbestos mat from the original crucible.

In addition to hydrolyzing the starch to soluble dextrine and dissolving the antacid present, the boiling with dilute acid removes certain soluble parts of the wood pulp, and it is therefore necessary that the boiling should be continued only long enough completely to hydrolyze the starch, and also that the strength of the acid should be no greater than that indicated (approximately 1:100). The effect of the use of stronger acid is shown in the following experiments on three samples of wood pulp:

SOLUBILITY OF WOOD PULP IN BOILING HYDROCHLORIC ACID OF VARYING DILUTION.

The samples of wood pulp were extracted with ether, dried, then extracted with cold water, and again dried. Two-gram parts of the extracted, dried samples of wood pulp were then boiled for 15 minutes each with 250 c. c. of water to which strong hydrochloric acid in quantities varying from 2.5 to 25 c. c. had been added. The residues were then filtered, washed, dried, and weighed. For comparison another 2-gram part of each dried sample was extracted with 250 c. c. of cold, dilute acid (1:10), washed, dried, and weighed.

Loss of wood pulp in weight on boiling with hydrochloric acid of different concentrations.

Volume of water used.	Volume of acid added.	Loss in weight.		
		Sample 157.	Sample 158.	Sample 175.
C. c.	*C. c.*	*Per cent.*	*Per cent.*	*Per cent.*
250	2.5	11.71	10.35	12.55
250	5.0	14.44	13.25	15.35
250	10.0	18.10	17.95	19.35
250	20.0	21.17	23.95	22.92
250	25.0	22.63	23.21	25.91

By extraction with 250 c. c. of cold acid (1:10) sample 157 lost 3.60 per cent, sample 158 lost 3.97 per cent, and sample 175 lost 4.10 per cent, respectively.

It was observed that as the concentration of the acid was increased the solubility of the wood-pulp samples increased. Even with 1 part

acid to 100 parts water, over 10 per cent of the original dry weight of wood pulp was dissolved by boiling.

EXAMINATION OF ACID SOLUTION.

The inorganic substances dissolved by either the extraction with cold hydrochloric acid (1:10) or boiling with dilute hydrochloric acid (1:100) are determined in the filtrates from the insoluble residue by the usual methods.

DETERMINATION OF ALUMINUM AND IRON.

Both aluminum and iron may be present in small proportions as impurities or in larger proportions if metallic aluminum powder or ferric oxide were used as actual ingredients of the original explosive.

If there are no metals other than Al, Fe, Ca, and Mg in the acid solution, the entire solution may be used for the successive determination of these substances but it is generally advisable to use only one-half, reserving the other half.

The acid solution is made slightly alkaline with NH_4OH and boiled for several minutes. If the precipitate of iron or aluminum hydroxides is very small, it may be disregarded and the calcium precipitated without previous filtration, otherwise the solution is filtered and the precipitate dried at 100° C., ignited, and weighed as Fe_2O_3 or Al_2O_3. If qualitative tests have been obtained for both iron and aluminum, the ignited oxides may be fused with potassium bisulphate, the fused mass dissolved in dilute H_2SO_4, the dissolved iron reduced to the ferrous condition by passing H_2S through the boiling solution, the free H_2S displaced from the solution by a current of CO_2, and the iron determined by titration with standard potassium permanganate solution.[a]

DETERMINATION OF CALCIUM.

The filtrate from the determination of iron and aluminum is used for the determination of calcium. More NH_4OH is added if the solution is not already strongly ammoniacal, the liquid heated to boiling, hot ammonium oxalate solution added in slight excess, and the boiling continued for several minutes. The precipitate is allowed to settle completely and then is filtered, washed, ignited, and weighed as CaO.

DETERMINATION OF MAGNESIUM.

Magnesium is determined in the filtrate from the calcium determination by evaporating to about 100 c. c., adding an excess of a solution of sodium hydrogen phosphate to the hot solution, then a

[a] Treadwell, F. P., Analytical chemistry, vol. 2, 1910, p. 103.

large excess of NH_4OH, and allowing the precipitate to settle for several hours. The precipitate is filtered, washed, ignited, and weighed as $Mg_2P_2O_7$.

DETERMINATION OF ZINC.

Any zinc which may be contained in the acid solution is determined in a separate aliquot part of the solution by precipitation with Na_2CO_3, as described on page 58.

DETERMINATION OF MANGANESE DIOXIDE.

Manganese dioxide, if the explosive contains it, will be only partly dissolved by extraction with cold dilute HCl (1:10) or by boiling with dilute HCl (1:100) to hydrolyze the starch.

The manganese dissolved in the acid solution is determined by concentrating a part of the solution and oxidizing to Mn_3O_4 by means of HNO_3 and $KClO_3$ crystals. The precipitated Mn_3O_4 is filtered off, ignited, and weighed. That part of the MnO_2 in the insoluble residue from the extraction with acid is determined by igniting to drive off the organic material, leaving the manganese in the form of Mn_3O_4, which is weighed direct.

A mixture of metallic zinc, manganese dioxide, and flour left after extraction with water was analyzed as follows: The mixture was transferred from the crucible to a beaker, treated with boiling dilute HCl (1:100) to hydrolyze the starch and dissolve the metallic zinc, a part of the MnO_2 also being dissolved. The residue was ignited and weighed as Mn_3O_4. The filtrate was evaporated to dryness with H_2SO_4 and ignited to convert the dissolved zinc and manganese to sulphates. These ignited sulphates were dissolved in a little water, and, without filtering off the small quantity of Mn_3O_4 resulting from decomposition of the $MnSO_4$, the solution was treated with an excess of strong HNO_3 and evaporated on the steam bath, with the frequent addition of crystals of potassium chlorate. The residue obtained by evaporation to complete dryness was redissolved in water, the Mn_3O_4 resulting from oxidation of the $MnSO_4$ was filtered, washed, ignited, and weighed. The zinc in the filtrate was determined by precipitation with Na_2CO_3 and ignition of the resulting $ZnCO_3$ to ZnO (see p. 58).

The total MnO_2 originally present was calculated from the combined weights of Mn_3O_4 obtained from the insoluble part and the acid solution.

DETERMINATION OF CALCIUM SILICIDE.

Although calcium silicide is a rather unusual ingredient of explosives, the fact that it is contained in at least one commercial

blasting explosive used in this country justifies a brief statement regarding its properties.

Calcium silicide ($CaSi_2$) is of value in explosive mixtures for the reason that its oxidation to CaO and SiO_2 produces a large amount of heat. It is a solid substance of lead-gray color, metallic luster, and scaly crystalline structure. On treatment with dilute hydrochloric acid it evolves a mixture of hydrogen and silicon hydride (SiH_4), the latter being spontaneously inflammable. This behavior serves as an excellent means of identifying calcium silicide.

The solution in hydrochloric acid may be used to determine the calcium, from which the amount of $CaSi_2$ may be calculated.

EXTRACTION WITH CARBON BISULPHIDE.

DETERMINATION OF SULPHUR.

Extraction with carbon bisulphide is necessary only when the explosive contains a large proportion of sulphur. The extraction with ether for the usual length of time will remove all of the sulphur if the amount is only a few per cent, but in case any considerable quantity of sulphur crystallizes out in the ether solution, it is advisable to extract with carbon bisulphide to insure complete removal of this constituent. The extraction is usually made on the dried and weighed residue remaining after extraction or boiling with dilute hydrochloric acid, and is carried out in the Wiley extraction apparatus in the same manner as the extraction with ether. After extraction with carbon bisulphide the excess solvent remaining in the crucibles is removed by suction, the crucibles left in a warm place until the odor of carbon bisulphide is no longer noted, and then placed in an oven at 95° to 100° C. to dry for 5 hours. Attention is called to the fact that the vapors of carbon bisulphide ignite at temperatures far below a red heat, hence there is danger in placing the crucibles wet with the solvent in the drying oven immediately after extraction.

The loss of weight of the residue is regarded as sulphur, or, in case freshly distilled carbon bisulphide has been used for the extraction, the extract may be evaporated in the bell-jar evaporator and the sulphur weighed direct. The weight of sulphur found by this extraction is added to that found in the ether extract.

EXTRACTION WITH ACETONE.

DETERMINATION OF NITROCELLULOSE AND NITROSTARCH.

Extraction with acetone is necessary only when the qualitative examination has indicated that the explosive contains nitrocellulose or nitrostarch.

Because of the fact that nitrocellulose is used in some explosives in very small amounts, its presence may readily be overlooked, especially if the explosive is not noticeably gelatinous in its consistency.

Both nitrocellulose and nitrostarch, being insoluble in ether, water, carbon bisulphide, and dilute hydrochloric acid, may be determined after all of these extractions have been made. It is important to note, however, that these organic nitrates are gradually decomposed by long-continued heating at temperatures as high as 100° C., and it is therefore advisable, when either nitrocellulose or nitrostarch have been found, that most of the drying, after the extractions with ether, water, etc., be done at a temperature of 70° C., with an additional half hour at 100° C. to insure constant weight.

METHOD OF TREATMENT WITH ACETONE.

The best method of dissolving nitrocellulose or nitrostarch by means of acetone is as follows: The residue is transferred from the crucible to a 100 c. c. beaker, the mat being left in the crucible if possible; the beaker is nearly filled with acetone, and the mixture permitted to stand for several hours with frequent stirring in order to insure complete solution. When gelatinous-like "flocks" no longer show in the solution, it is filtered through the original crucible, and the residue washed thoroughly with acetone. If the sample contains a large quantity of nitrostarch, as do some of the nitrostarch explosives, the solution may filter with difficulty; in that case the beaker should be allowed to stand until the insoluble residue has completely settled, the clear solution carefully decanted, and fresh acetone added to the insoluble residue before attempting to filter. In this manner most of the soluble material is removed before filtering, and the filter does not become so easily clogged.

The residue left in the filter after thorough washing with acetone is dried and weighed as usual, and the loss of weight regarded as nitrocellulose or nitrostarch, as the case may be. Which of these substances the explosive contains must be determined by microscopic examination as noted under "Qualitative Examination" (p. 15).

RECOVERY OF NITROCELLULOSE OR NITROSTARCH FROM ACETONE SOLUTION.

The organic nitrate dissolved in the acetone may be recovered by the following method: The acetone solution is slowly added, with continual stirring, to about twice its volume of water heated to 70° to 80° C., the mixture heated on the steam bath until all of the acetone has been evaporated, and the precipitated organic nitrate filtered off.

The precipitate may be dried and weighed, its weight serving as a check on the determination of loss of weight on extraction, and its nitrogen content determined by means of the nitrometer.

EXAMINATION OF THE INSOLUBLE RESIDUE.

The insoluble residue left after all extractions have been completed may contain any of the substances noted in the list of components on page 13. All of these substances have been found in permissible explosives tested by the bureau, and there are other ones possible which might be added to the list.

MICROSCOPIC EXAMINATION.

Absolute identification of the substances contained in the insoluble residue from the last extraction is frequently difficult and often is made possible only by means of a careful microscopic examination. Familiarity with the appearance of such materials under the microscope is therefore of great assistance.

Two types of microscopes have been found useful in the bureau's laboratory—a binocular microscope, by means of which magnifications from about 10 to 75 diameters may be obtained, and an ordinary petrographic microscope which gives magnifications ranging from about 20 to 300 diameters. The former type is the more valuable for the examination of coarse materials, because of the great depth of focus obtainable, whereas the petrographic microscope, with its higher powers of magnification, is useful for the identification of finer materials.

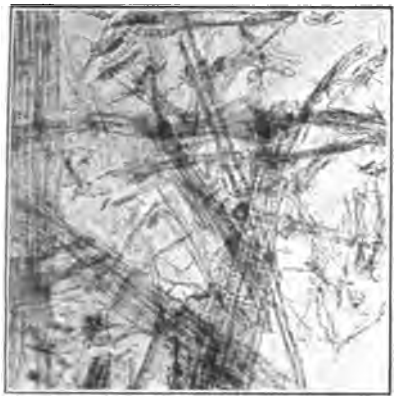
PREPARATION OF SLIDES.

Careful mounting of the samples for microscopic examination is not at all necessary. The usual method is to spread a small quantity of the dry residue uniformly over the surface of the glass microscope slide in a thin layer so that individual particles are separated from each other, placing the slide directly under the objective, without a cover glass.

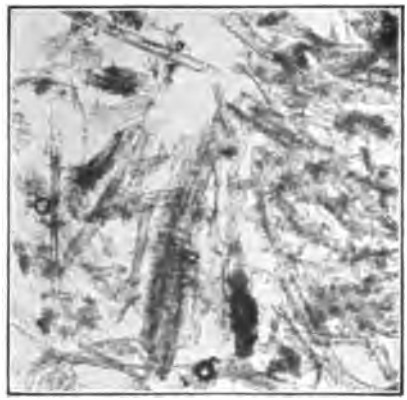
The most suitable magnification to use is determined by trial. A number of samples of different materials that may be found in the insoluble residue are shown in Plates I, II, and III under magnifications of 10 to 150 diameters.

In Plate I, *A* and *B*, is shown wood pulp of different grades; Plate I, *C*, shows fine sawdust with its characteristic bundles of fibers; in Plate I, *D* and *E*, different types of kieselguhr or infusorial earth are illustrated; and Plate I, *F*, shows the crude fiber from coarse wheat flour (middlings) left after hydrolysis of the starch.

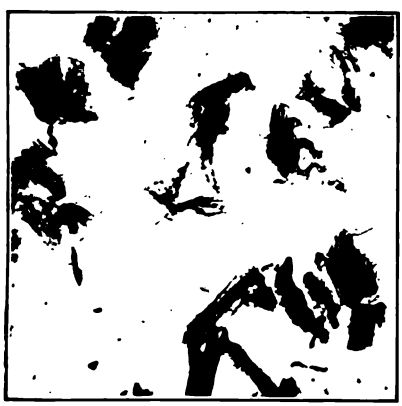
A and *B*, Plate II, represent cotton (cellulose) and nitrocellulose, respectively, both of which appear alike under the microscope unless examined in polarized light, when the unnitrated fibers appear in brilliant colors and the nitrated fibers are dark; Plate II, *C*, repre-



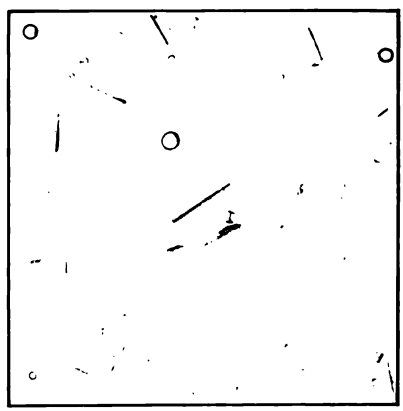
A. WOOD PULP NO. 1 (× 50).



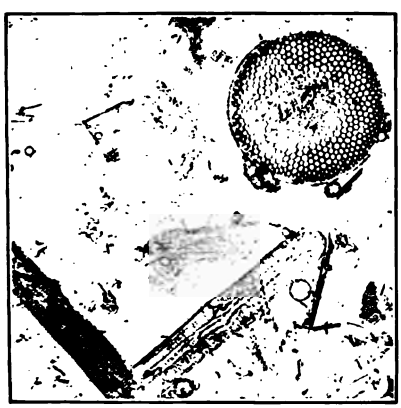
B. WOOD PULP NO. 2 (× 50).



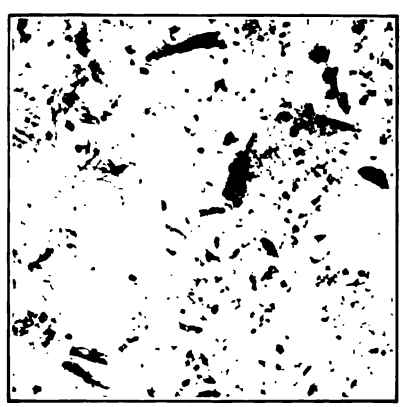
C. SAWDUST (× 25).



D. INFUSORIAL EARTH NO. 1 (× 150).



E. INFUSORIAL EARTH NO. 2 (× 150).



F. CRUDE FIBER FROM WHEAT MIDDLINGS (× 25).

sents fine wheat flour; Plate II, *D*, fine wheat flour mixed with wood pulp; Plate II, *E*, coarse wheat flour (middlings); and Plate II, *F*, fine corn meal.

A number of the more unusual carbonaceous combustible materials used in explosives are illustrated in Plate III. In this plate *A* shows peanut-shell meal; *B*, rice hulls; *C*, corncob meal (commercially known as "Corona meal"); and *D*, "vegetable ivory" meal, a product obtained by pulverizing the waste resulting in the manufacture of buttons from "vegetable ivory" nuts ("corosos" nuts), the fruit of the phytelephas macrocarpa or "ivory nut" tree of tropical countries. The materials shown in Plate III have practically no absorbent properties, their chief use in explosives being to serve as combustible materials.

DETERMINATION OF ASH.

The determination of "ash" in an explosive, that is, natural inorganic insoluble constituents of the carbonaceous materials, plus any insoluble nonvolatile impurities in the various salts is, of course, possible only when no inorganic substances are actual constituents of the insoluble residue. The amount of such inorganic materials may be determined, however, by burning off the organic matter, as in the determination of ash, and weighing the resulting nonvolatile residue, which includes the ash.

One of the duplicate samples of the dried and weighed insoluble residue is used for the determination of ash, or of combined ash and inorganic substances. This residue may be ignited in the original filtering crucible in which it was dried, the organic material being burned by first heating it very gradually with a small free flame of a burner until combustible gases cease to be evolved, then increasing the size of the flame and tilting the crucible so that the carbon is finally burned off, leaving a constant weight of inorganic residue.

If desired, the ignition may be carried out in a platinum crucible by transferring to it all the dried and weighed residue from the original filtering crucible. This method involves an additional weighing (of the platinum crucible) but the combustion is more rapid in the platinum crucible than in the porcelain or alundum filtering crucibles.

The proportion of ash is usually not over 0.20 per cent. If it is over 0.5 per cent, the residue probably contains, in addition to the real ash of the carbonaceous materials, insoluble inorganic impurities from some of the saline ingredients, or possibly small amounts of added inorganic material, such as kieselguhr, clay, etc. A high ash content may also indicate that either the water or acid extractions

have not been complete. In this respect the determination of ash may be regarded as a check on the analysis.

THE ULTIMATE COMPOSITION OF CARBONACEOUS INGREDIENTS.

In making calculations of the reactions involved in the explosive decomposition of explosive mixtures for the purpose of calculating the temperatures, gas volumes, etc., resulting from explosion, it was essential that the average ultimate composition of the various carbonaceous ingredients be known so that the formulas used to represent the composition of these substances might be as nearly correct as possible.

ULTIMATE COMPOSITION OF WOOD PULP.

The results of analyses of different woods by various investigators were collected and averaged. A summary of these results is shown in the following table:

Results of analyses of woods by different investigators.

[Average ultimate composition.]

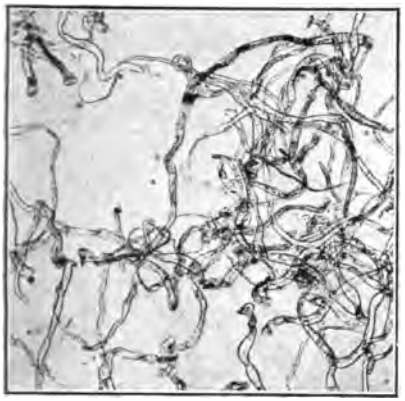
Designation of test.	Proportion of—			Authority.	Remarks.
	Carbon.	Hydrogen.	Oxygen.[a]		
	Per cent.	*Per cent.*	*Per cent.*		
A	49.77	6.15	44.08	Gottlieb [b]	Average of 7 kinds of wood.
B	49.50	6.00	44.50	Poole [c]	
C	50.64	6.17	43.19	Chevandier [d]	Average of 5 kinds of wood.
D	50.00	6.00	44.00	Aufhäuser [e]	
E	49.20	6.10	44.70	Chevandier [f]	Average of 13 kinds of wood.
F	50.00	6.00	44.00	Muck [g]	
Average	49.85	6.07	44.08		

[a] Includes small amount of nitrogen.
[b] Poole, H., Calorific value of fuels, 1905, p. 86.
[c] Poole, H., op. cit., p. 85.
[d] Gody, L., Traité theorique et pratique des matières explosives, 1907, p. 67.
[e] Aufhäuser, —, Die spezifischen Eigenschaften und Unterschiede der festen und flüssigen Brennstoffe und ihre technische Bedeutung: Glückauf, Jahrg. 49, 1913, p. 604.
[f] Jüptner, H. von, Lehrbuch der chemischen Technologie der Energien, Bd. 1, 1905, p. 154.
[g] Jüptner, H. von, op. cit., p. 170.

This average composition corresponds to the empirical formula $C_{15}H_{21.9}O_{9.9}$, or expressed in round numbers, $C_{15}H_{22}O_{10}$, which is the formula used by chemists of the bureau in previous works.[a]

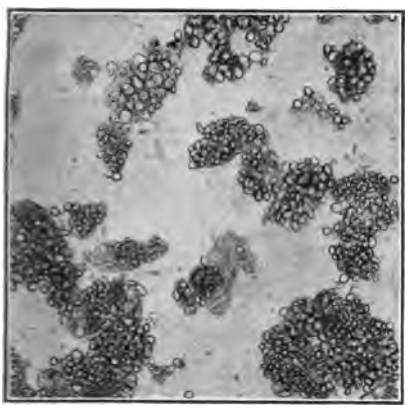
In order to check this result, by tests of wood pulp actually used in the manufacture of explosives in this country, samples of wood pulp were obtained from various manufacturers of permissible explo-

[a] Hall, C., Snelling, W. O., and Howell, S. P., Investigations of explosives used in coal mines: Bull. 15, Bureau of Mines, 1912, p. 62.

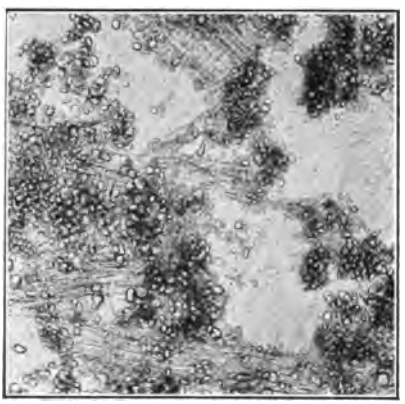


A. CELLULOSE (COTTON) (× 50).

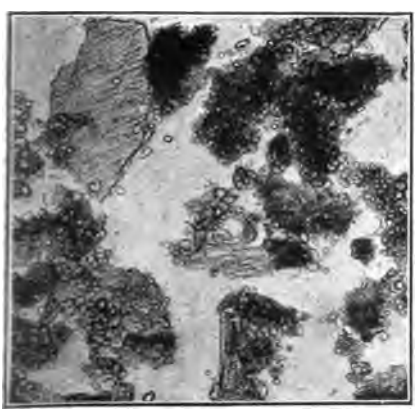
B. NITROCELLULOSE (× 50).



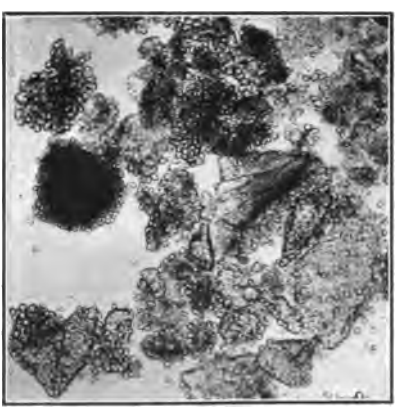
C. WHEAT FLOUR (FINE) (× 50).



D. WHEAT FLOUR (FINE) AND WOOD PULP (× 50).



E. WHEAT FLOUR (MIDDLINGS) (× 50).



F. CORN MEAL (× 50).

sives and submitted to careful ultimate analyses by the combustion method, with the following results:

Results of analyses of wood pulp used in explosives in the United States.

[Analyses made under direction of A. C. Fieldner.]

Designation of sample. (Lab. No.)	Composition of samples "as received."				Composition of samples calculated free from ash and moisture.		
	Moisture.	Ash.	Carbon.	Hydrogen.	Carbon.	Hydrogen.	Oxygen (by difference).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
156	9.33	0.59	46.14	6.68	51.22	6.25	42.53
157	6.83	.70	47.20	6.37	51.04	6.07	42.89
158	6.53	.23	48.40	6.50	51.91	6.18	41.91
159	6.50	.24	47.53	6.42	50.99	6.11	42.90
163	7.35	.32	46.40	6.45	50.26	6.10	43.64
164	5.73	.38	48.19	6.35	51.32	6.09	42.59
165	9.30	.48	46.18	6.41	51.19	5.96	42.85
166	6.63	.46	47.40	6.44	51.03	6.13	42.84
167	6.90	.82	47.22	6.30	51.17	5.99	42.84
Average	.....	.....	.....	.....	51.12	6.10	42.78

The average composition of the nine samples of wood pulp—51.12 per cent carbon, 6.10 per cent hydrogen, and 42.78 per cent oxygen—does not differ widely from the average of the results found in the literature (see p. 76). The empirical formula calculated from these results is $C_{15}H_{21.5}O_{9.5}$, which, like the formula on page 76 may also be expressed as $C_{15}H_{22}O_{10}$.

This formula for wood pulp has therefore been accepted for use in calculations based upon the chemical reactions involved in the explosion of blasting explosives containing this ingredient.

ULTIMATE COMPOSITION OF CORN MEAL.

In view of the fact that no results of ultimate analyses of corn meal could be found in the literature on the subject, an attempt was made to calculate such an analysis from the results of average proximate analyses. The following was selected as an average proximate analysis of corn meal:[a]

Composition of corn meal.

Constituent.	Proportion in corn meal.	
	By analysis.	Calculated on ash-free and moisture-free basis.
	Per cent.	*Per cent.*
Moisture	12.57	.....
Proteids	7.13	8.13
Ether extract	1.33	1.52
Crude fiber	.87	.99
Carbohydrates	78.36	89.36
Ash	.61	.....

[a] Wiley, H. W., Composition of maize (Indian corn), including the grain, meal, stalks, pith, fodder, and cobs: Bureau of Chemistry, Department of Agriculture, Bull. 50, 1898, p. 13.

The composition of the proteid was assumed to be as follows: C, 55.22 per cent; H, 7.25 per cent; N, 16.15 per cent; S, 0.61 per cent; O, 20.77 per cent, this being the average composition of the zeins which compose the proteids.[a]

The composition of the ether extract was calculated as C, 75.16 per cent, H, 11.72 per cent, and O, 12.69 per cent from the average of the compositions given by König[b] and Hopkins.[c]

The crude fiber was assumed to have the same formula as wood pulp, $C_{15}H_{22}O_{10}$, or approximately 49.72 per cent C, 6.08 per cent H, and 44.2 per cent O.

The carbohydrates were assumed to be sugar and starch, the sugar constituting 1.75 per cent of the total meal,[d] or 2.22 per cent of the moisture-free and ash-free material.

If the above assumptions are accepted and the small proportion of sulphur in the proteids be disregarded, the ultimate composition of the moisture-free and ash-free material, calculated from the proximate analysis, is as follows: C, 45.77 per cent; H, 6.35 per cent; O, 46.51 per cent; N, 1.37 per cent. This composition gives approximately the empirical formula, $C_{15}H_{24}O_{11.4}N_{0.4}$.

The average of three analyses of corn meal, kindly reported to the writer by Prof. H. P. Ormsby, of Pennsylvania State College, is as follows: C, 46.46 per cent; H, 6.74 per cent; O, 45.06 per cent; N, 1.74 per cent. The formula calculated from this composition is $C_{15}H_{26}O_{10.9}N_{0.5}$, which agrees closely with the formula calculated from the proximate analysis.

Both of these results were closely confirmed by the results of two analyses of corn meal by A. C. Fieldner, of the Bureau of Mines, which averaged 46.87 per cent C, 6.50 per cent H, 45.43 per cent O, 1.20 per cent N, corresponding to the formula $C_{15}H_{25}O_{11}N_{0.3}$.

The average of the three formulas obtained as above noted is $C_{15}H_{25}O_{11.1}N_{0.4}$, which, for all practical purposes, may be written $C_{15}H_{25}O_{11}$. It is believed that this formula approximates the average composition of dry corn meal, and may be used in calculations where a formula for corn meal is required.

ULTIMATE COMPOSITION OF WHEAT FLOUR.

The ultimate composition of wheat flour, or middlings, was calculated, by the method used for corn meal, from an average of a large number of proximate analyses. The calculated composition

[a] Wiley, H. W., Composition of maize (Indian corn), including the grain, meal, stalks, pith, fodder, and cobs: Bureau of Chemistry, Department of Agriculture, Bull. 50, 1898, p. 9.

[b] Blyth, A. W., and Blyth, M. W., Foods, their composition and analysis, 1903, p. 216.

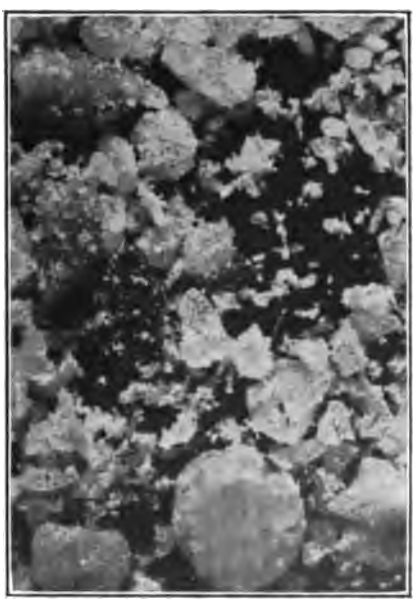
[c] Benedikt-Ulzer, Analyse der Fette und Wachsarten, Aufl. 5, 1908, p. 715.

[d] Bryan, A. G., Given, A., and Straughn, M. N., Extraction of grains and cattle foods for the determination of sugars; a comparison of the alcohol and the sodium digestions: Bureau of Chemistry, Department of Agriculture, Circular 71, 1911, 14 pp.

A. PEANUT-SHELL MEAL (× 15).

B. RICE HULLS (× 15).

C. CORNCOB MEAL (× 15).



D. VEGETABLE-IVORY MEAL (× 15).

was 46.65 per cent C, 6.43 per cent H, 44.10 per cent O, 2.67 per cent N, 0.15 per cent S, and corresponds to the formula $C_{15}H_{24\cdot8}O_{10\cdot6}N_{0\cdot7}$ (the sulphur being disregarded).

Four samples of wheat middlings analyzed by A. C. Fieldner gave an average composition of 46.46 per cent C, 6.44 per cent H, 44.61 per cent O, 2.33 per cent N, and 0.16 per cent S, a composition that corresponds to the formula $C_{15}H_{25}O_{10\cdot8}N_{0\cdot6}$.

Both of these formulas may, like those for corn meal, be expressed as $C_{15}H_{25}O_{11}$, which formula, it is considered, may be used in explosives calculations as being approximately accurate for dry wheat flour, or middlings.

CONCLUDING REMARKS.

In describing the methods employed by the Bureau of Mines for the analysis of explosives submitted for tests, it has been impossible to discuss in detail the methods used for the analysis of all the various combinations of ingredients which have been found in the many different explosives examined, or which may be met with in explosives submitted in the future. It has frequently been necessary to devise methods for the analysis of some unusual mixture of ingredients in an explosive.

It is believed, however, that the methods described in this bulletin will be of material assistance to chemists engaged in the analysis of the various types of blasting explosives.

APPENDIX.

TOLERANCES FOR PERMISSIBLE EXPLOSIVES.

At a conference on June 7, 1915, between manufacturers of explosives and the bureau's engineers and chemists an agreement was reached providing for reasonable limits of variation or "tolerances" in the results of analyses and tests of permissible explosives. If these tolerances are exceeded by a given lot of any permissible explosive it is not permissible. The tolerances established, which were made effective July 1, 1915, are stated as follows:

In order to define more exactly what is meant by the phrase "similar in all respects" in the definition of a permissible explosive, namely, "an explosive is called a permissible explosive when it is similar in all respects to the sample that passed certain

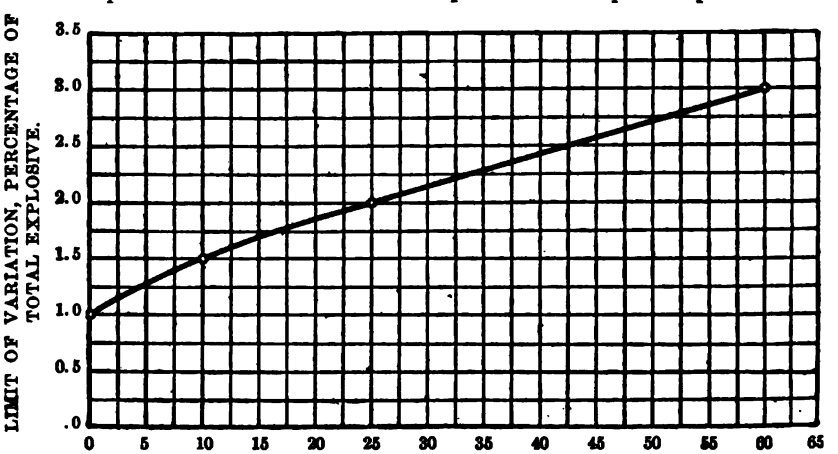


FIGURE 7.—Curve of limit variation in composition of permissible explosives.

tests by the United States Bureau of Mines, and when it is used in accordance with the conditions prescribed by this bureau," the following tolerances are recommended for field samples or manufacturers' samples of explosives, beyond which such lot of explosives can not vary and still be considered permissible for use in coal mines: *Provided*, That where the Bureau of Mines finds a sample which does not come up to the tolerance limits, the bureau shall simply declare that particular lot of explosives not permissible, and a copy of the notification to the consumer or owner shall be furnished the manufacturer, the notification to state that the explosive did not meet the tolerance requirements for moisture or ingredients, etc., as the case might be.

Chemical analysis.—Moisture, to be fixed by a sliding scale of from 1½ per cent at zero to 4 per cent at 10 per cent of moisture in original sample, this tolerance being on total percentage of moisture in the explosive.

Other ingredients (or their equivalents) in quantities not exceeding 60 per cent, according to a curve [shown in figure 7]. For ingredients in quantities of 60 per cent

or more, the tolerance shall be plus or minus 3 per cent: *Provided*, That the ingredients of a permissible explosive shall be considered to be those substances reported as found by the Bureau of Mines in the original sample of that explosive submitted for test as to its permissibility: *And provided further*, That an equivalent shall be considered to be a substance which would not materially alter the properties of the explosive and which would produce the same result as the original substance.

Products of combustion (determined by Bichel gage test).—The volume of poisonous gases from 680 grams of the explosive, including its wrapper, must be less than 158 liters, except that in case the first test yields 158 liters or more of poisonous gases per 680 grams of the explosive, including its wrapper, the average result of three tests agreeing within 5 per cent of each other shall be taken, and no explosive shall remain permissible when this average for poisonous gases exceeds the above standard limit.

Physical tests.[a]—

Rate of detonation (the average of three trials with Mettegang's recorder), plus or minus 15 per cent.

Unit deflective charge (the average of three trials with the ballistic pendulum), plus or minus 10 per cent.

Grams of wrapper per 100 grams of explosive, plus or minus 2.0 grams (average of four determinations): *Provided*, That the manufacturers shall submit samples of all different sizes of cartridges, to be considered as part of the original sample, the amount of wrapper to be determined for each size of sample: *And provided further*, That the tolerances as suggested shall be determined in comparison with the various diameters of samples as submitted with the original sample.

Apparent specific gravity of cartridge, by sand, plus or minus 7.5 per cent (average of four determinations): *Provided*, that actual density shall be determined on cartridges of the same diameter as the standard: *And provided further*, That manufacturers shall be required to submit samples of all sizes.

Gas and dust gallery No. 1.—No ignition must be obtained in each of one or more trials. Note: In the retesting of permissible explosives by tests 1, 3, and 4,[b] the charges of the explosives fired will be reduced 10 per cent in weight from the weights originally used in order to eliminate any likelihood of a failure being due to the natural variations in the gallery conditions.

Pendulum friction test.—Each explosive must pass a test of 10 trials under the same conditions as originally tested, except that the height of fall of the wood-fiber shoe will be reduced by 10 per cent in order to eliminate any likelihood of a failure being due to the natural variations in test conditions.

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[a] For methods of making these tests, see Hall, Clarence, and Howell, S. P., Tests of permissible explosives: Bull. 66, Bureau of Mines, 1913, 313 pp.

[b] Op. cit., p. 303.

PUBLICATIONS ON MINE ACCIDENTS AND TESTS OF EXPLOSIVES.

A limited supply of the following publications of the Bureau of Mines is temporarily available for free distribution. Requests for all publications can not be granted, and applicants should select only those publications that are of especial interest to them. All requests for publications should be addressed to the Director, Bureau of Mines, Washington, D. C.

BULLETIN 15. Investigations of explosives used in coal mines, by Clarence Hall, W. O. Snelling, and S. P. Howell, with a chapter on the natural gas used at Pittsburgh, by G. A. Burrell, and an introduction by C. E. Munroe. 1912. 197 pp., 7 pls., 5 figs.

BULLETIN 17. A primer on explosives for coal miners, by C. E. Munroe and Clarence Hall. 61 pp., 10 pls., 12 figs. Reprint of United States Geological Survey Bulletin 423.

BULLETIN 20. The explosibility of coal dust, by G. S. Rice, with chapters by J. C. W. Frazier, Axel Larsen, Frank Haas, and Carl Scholz. 204 pp., 14 pls., 28 figs. Reprint of United States Geological Survey Bulletin 425.

BULLETIN 48. The selection of explosives used in engineering and mining operations, by Clarence Hall and S. P. Howell. 1913. 50 pp., 3 pls., 7 figs.

BULLETIN 51. The analysis of black powder and dynamite, by W. O. Snelling and C. G. Storm. 1913. 80 pp., 5 pls., 5 figs.

BULLETIN 56. First series of coal-dust explosion tests in the experimental mine, by G. S. Rice, L. M. Jones, J. K. Clement, and W. L. Egy. 1913. 115 pp., 12 pls., 28 figs.

BULLETIN 59. Investigations of detonators and electric detonators, by Clarence Hall and S. P. Howell. 1913. 73 pp., 7 pls., 5 figs.

BULLETIN 66. Tests of permissible explosives, by Clarence Hall and S. P. Howell. 1913. 313 pp., 1 pl., 6 figs.

BULLETIN 68. Electric switches for use in gaseous mines, by H. H. Clark and R. W. Crocker. 1913. 40 pp., 6 pls.

BULLETIN 69. Coal-mine accidents in the United States and foreign countries, compiled by F. W. Horton. 1913. 102 pp., 3 pls., 40 figs.

BULLETIN 72. Occurrence of explosive gases in coal mines, by N. H. Darton. 1915. 248 pp., 7 pls., 33 figs.

BULLETIN 80. A primer on explosives for metal miners and quarrymen, by C. E. Munroe and Clarence Hall. 1915. 122 pp., 15 pls., 7 figs.

TECHNICAL PAPER 6. The rate of burning of fuse as influenced by temperature and pressure, by W. O. Snelling and W. C. Cope. 1912. 28 pp.

TECHNICAL PAPER 7. Investigations of fuse and miners' squibs, by Clarence Hall and S. P. Howell. 1912. 19 pp.

TECHNICAL PAPER 11. The use of mice and birds for detecting carbon monoxide after mine fires and explosions, by G. A. Burrell. 1912. 15 pp.

TECHNICAL PAPER 12. The behavior of nitroglycerin when heated, by W. O. Snelling and C. G. Storm. 1912. 14 pp., 1 pl., 2 figs.

TECHNICAL PAPER 13. Gas analysis as an aid in fighting mine fires, by G. A. Burrell and F. M. Seibert. 1912. 16 pp., 1 fig.

TECHNICAL PAPER 17. The effect of stemming on the efficiency of explosives, by W. O. Snelling and Clarence Hall. 1912. 20 pp., 11 figs.

TECHNICAL PAPER 18. Magazines and thaw houses for explosives, by Clarence Hall and S. P. Howell. 1912. 34 pp., 1 pl., 5 figs.

TECHNICAL PAPER 21. The prevention of mine explosions, report and recommendations, by Victor Watteyne, Carl Meissner, and Arthur Desborough. 12 pp. Reprint of United States Geological Survey Bulletin 369.

TECHNICAL PAPER 30. Mine-accident prevention at Lake Superior iron mines, by D. E. Woodbridge. 1913. 38 pp., 9 figs.

TECHNICAL PAPER 39. The inflammable gases in mine air, by G. A. Burrell and F. M. Seibert. 1913. 24 pp., 2 figs.

TECHNICAL PAPER 44. Safety electric switches for mines, by H. H. Clark. 1913. 8 pp.

TECHNICAL PAPER 47. Portable electric mine lamps, by H. H. Clark. 1913. 13 pp.

TECHNICAL PAPER 48. Coal-mine accidents in the United States, 1896–1912, with monthly statistics for 1912, compiled by F. W. Horton. 1913. 74 pp., 10 figs.

TECHNICAL PAPER 61. Metal-mine accidents in the United States during the calendar year 1912, compiled by A. H. Fay. 1913. 76 pp., 1 fig.

TECHNICAL PAPER 62. Relative effects of carbon monoxide on small animals, by G. A. Burrell, F. M. Seibert, and I. W. Robertson. 1914. 23 pp.

TECHNICAL PAPER 67. Mine signboards, by Edwin Higgins and Edward Steidle. 1913. 15 pp., 1 pl., 4 figs.

TECHNICAL PAPER 71. Permissible explosives tested prior to January 1, 1914, by Clarence Hall. 1914. 12 pp.

TECHNICAL PAPER 77. Report of the Committee on Resuscitation from Mine Gases, by W. B. Cannon, G. W. Crile, Joseph Erlanger, Yandell Henderson, and S. J. Meltzer. 1914. 36 pp., 4 figs.

TECHNICAL PAPER 92. Quarry accidents in the United States during the calendar year 1913, compiled by A. H. Fay. 1914. 76 pp.

TECHNICAL PAPER 94. Metal-mine accidents in the United States during the calendar year 1913, compiled by A. H. Fay. 1914. 73 pp.

TECHNICAL PAPER 100. Permissible explosives tested prior to March 1, 1915, by S. P. Howell. 1915. 16 pp.

TECHNICAL PAPER 107. Production of explosives in the United States during the calendar year 1914, by A. H. Fay. 1915. 14 pp.

TECHNICAL PAPER 111. Safety in stone quarrying, by O. P. Bowles. 1915. 48 pp. 5 pls., 4 figs.

TECHNICAL PAPER 119. The limits of inflammability of mixtures of methane and air, by G. A. Burrell and G. G. Oberfell. 1915. 30 pp., 4 figs.

MINERS' CIRCULAR 5. Electrical accidents in mines, their causes and prevention, by H. H. Clark, W. D. Roberts, L. C. Ilsley, and H. F. Randolph. 1911. 10 pp., 3 pls.

MINERS' CIRCULAR 7. Use and misuse of explosives in coal mining, by J. J. Rutledge, with a preface by J. A. Holmes. 1913. 52 pp., 8 figs.

MINERS' CIRCULAR 8. First-aid instructions for miners, by M. W. Glasgow, W. A. Raudenbush, and C. O. Roberts. 1913. 67 pp., 51 figs.

MINERS' CIRCULAR 11. Accidents from mine cars and locomotives, by L. M. Jones. 1912. 16 pp.

MINERS' CIRCULAR 12. The use and care of miners' safety lamps, by J. W. Paul. 1913. 16 pp., 4 figs.

MINERS' CIRCULAR 13. Safety in tunneling, by D. W. Brunton and J. A. Davis. 1913. 19 pp.

MINERS' CIRCULAR 14. Gases found in coal mines, by G. A. Burrell and F. M. Seibert. 1914. 23 pp.

MINERS' CIRCULAR 15. Rules for mine-rescue and first-aid field contests, by J. W. Paul. 1913. 12 pp.

MINERS' CIRCULAR 16. Hints on coal-mine ventilation, by J. J. Rutledge. 1914. 22 pp.

MINERS' CIRCULAR 17. Accidents from falls of rock or ore, by Edwin Higgins. 1914. 15 pp., 8 figs.

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Bulletin 97

DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
VAN. H. MANNING, DIRECTOR

SAMPLING AND ANALYZING FLUE GASES

BY

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AND

F. K. OVITZ

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SAMPLING AND ANALYZING FLUE GASES.

By Henry Kreisinger and F. K. Ovitz.

INTRODUCTION.

Some of the investigations conducted by the Bureau of Mines have for their object the collecting and disseminating of information regarding methods by which the fuels of the country may be most efficiently used. As the analysis of flue gases tends to develop better methods of firing, which in turn reduces waste of fuel, the Bureau of Mines in this bulletin presents for the benefit of those in charge of boiler plants and all other persons interested detailed information on methods of sampling and analyzing flue gases, and on the utilization of the analyses in promoting boiler-room economy.

This bulletin is intended to be a companion to Technical Paper 80,[a] and is written in plain and nontechnical language, as far as possible, so that it may be readily understood by persons who have not had the advantage of a technical education. Whenever possible, illustrations of apparatus and methods of handling have been used rather than elaborate descriptions.

The material presented in this report is arranged in two parts. The first part contains the description of the apparatus and the methods used in sampling and analyzing flue gases. The second part gives experimental results obtained with the different methods of sampling and collecting flue gas that are recommended in the first part of the report.

Only simple apparatus and methods are considered, as they are accurate enough to show the large heat losses due to the use of too much air, and are also accurate enough to indicate any incomplete combustion losses of economic importance. Without doubt the loss due to large excess of air is the greatest one in the boiler room, and can usually be greatly reduced by making proper use of gas analysis. Before engineers in the isolated industrial plants can be induced to analyze for small traces of combustible gases, they must be first taught how to analyze for carbon dioxide (CO_2), and they must learn to appreciate the great possibilities of reducing loss from large excess of air. Furthermore, in the face of the great difficulty of obtaining a fair

[a] Kreisinger, Henry, Hand firing soft coal under power-plant boilers: Tech. Paper 80, Bureau of Mines, 1915, 83 pp.

average sample, discussed in the second part of this bulletin, it is doubtful whether more delicate apparatus for analysis and more refined methods would be of much advantage. Those who wish to obtain information on the more accurate methods of analysis of gases are referred to Bureau of Mines Bulletin 12[a] and Technical Paper 31.[b]

GENERAL STATEMENT.

The determination of the composition of flue gases involves two distinct operations—the sampling of the gases, and the analysis of the sample. Of the two operations the sampling is more important than the analysis, for if the sampling is not done properly the analysis itself is of no value. Also, sampling is usually more laborious than analysis. Great care is necessary, just as it is necessary in sampling coal. In sampling either flue gas or coal a carelessly taken sample is worthless for determining the quality of the gas or coal. Therefore, the device and the methods used in sampling should be well planned and the sampling itself carefully executed.

THE SAMPLING OF FLUE GASES.

In sampling flue gases a small quantity is taken from the stream of gases at any desirable place within a boiler setting. The sample may be taken from the furnace, from among the boiler tubes, or from the breeching, according to the object of the sampling and analysis. The volume of the sample may range from one-half of a cubic foot to a few cubic inches.

In sampling the flue gases the most important feature is that the sample shall closely represent the composition of the stream of gases at the place of sampling, and the device used in sampling must be designed with this object in view. A simple design of such a device for sampling gases in the uptake of a boiler is shown in figure 1.

It consists mainly of a special piece of piping, called the sampler, inserted in the uptake, two collecting bottles, and a steam ejector. These parts are connected by a small-size standard iron piping or ¼-inch copper tubing, as shown in the figure. The operation of the device is indicated by the arrow heads. The steam ejector causes a continuous flow of gas from the uptake through the piping. A small amount of this gas is drawn into the upper collecting bottle and is the sample to be analyzed. The remainder of the gas is rejected with the steam from the ejector through the discharge pipe.

The ejector and the collecting bottles may be placed in any convenient place. In most plants the engine room is the best location;

[a] Frazer, J. C. W., and Hoffman, E. J., Apparatus and methods for the sampling and analysis of furnace gases: Bull. 12, Bureau of Mines, 1911, 22 pp.

[b] Burrell, G. A., and Seibert, F. M., Apparatus for the exact analysis of flue gas: Tech. Paper 31, Bureau of Mines, 1913, 12 pp.

usually they can be placed along the wall separating the engine room from the boiler room. Such location requires a short pipe connection which is always advantageous and easily supervised by the engineer.

Figure 2 shows the location of the ejector, the collecting bottles, and the pipe connections in a typical steam plant. Each boiler is equipped with a separate sampling device independent of the other boilers. One ejector will serve several sampling devices.

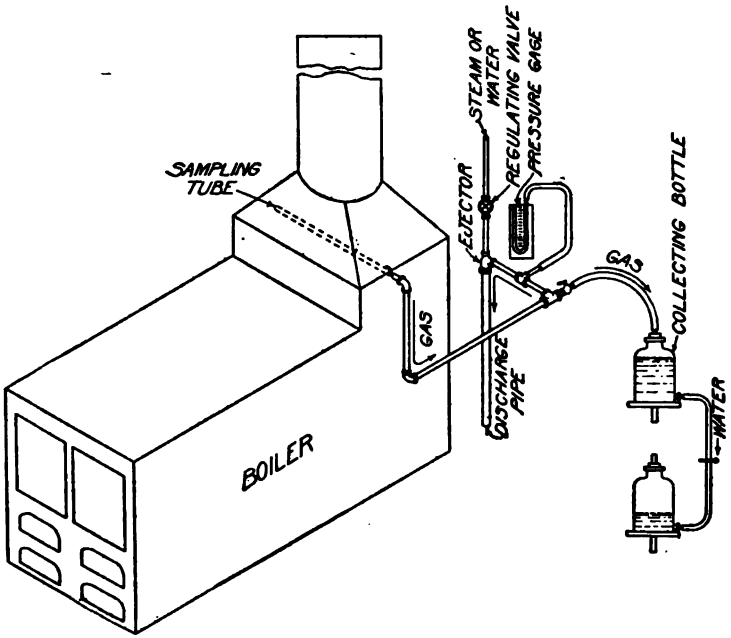


FIGURE 1.—General arrangement of the parts of a flue-gas sampling device.

TYPES OF SAMPLERS.

That part of the sampling device that is inserted into the uptake or into any other place from which it is desired to take a gas sample is called the sampling tube or the sampler. The construction and the location of the sampler are of considerable importance in obtaining a representative gas sample.

SIMPLE OPEN-END SAMPLER.

The simplest and the most commonly used sampler is a plain standard ¼-inch iron pipe placed with the open end in the center of the uptake as shown in figure 3. The gas is taken only from the center of the stream flowing through the uptake, and the sample collected represents only that part of the stream.

The parts of the stream farther away from the center may be and usually are of somewhat different composition than the central part. This difference may amount in some cases to 2 per cent in the CO_2 content; that is, in the central part the gases may contain 8 per cent of CO_2, in another part farther away from the center 10 per cent, and in some other part only 6 per cent. If the setting is very leaky the variation may be greater. In water-tube boilers if the setting is fairly tight the composition of the central part will be within about 0.5 per cent of the average composition of the whole stream. In fire-tube boilers the difference may be as much as 2 per cent. These variations are discussed in the section on "Experimental Results of Sampling and Collecting Flue Gases."

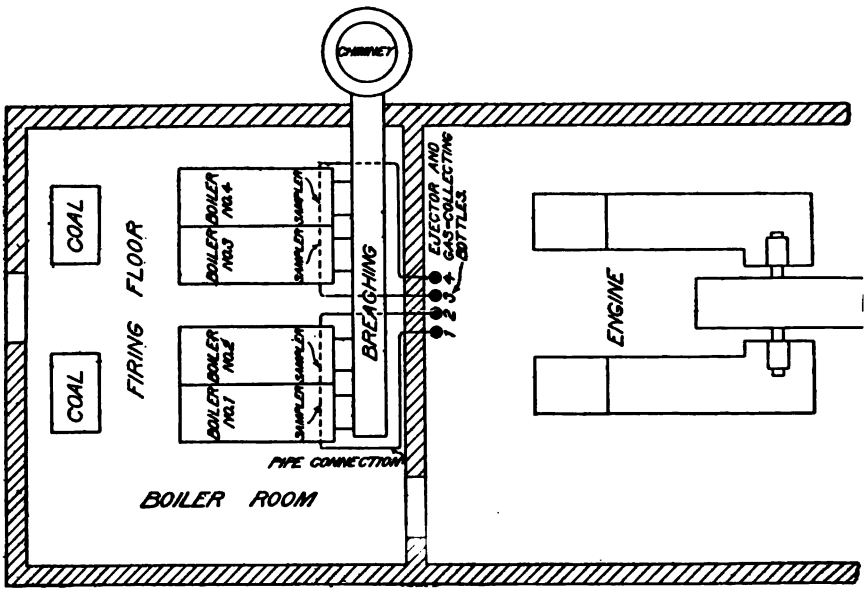


FIGURE 2.—Position of gas-sampling devices and their connections in a typical steam plant. Each of the four boilers is equipped with a separate sampling device.

The open-end single-tube sampler shown in figure 3 has the merit of simplicity. It is easily put in place and can be cleaned readily in case it becomes clogged with soot or ashes. When this sampler is installed the only precaution to be taken is that the open end be placed in the center of the uptake at least 3 feet below the damper and not any nearer than 1 foot to the steam drum. Figure 3 shows a good position for such sampler in a water-tube boiler installation. The sampler is inserted into the uptake through a hole drilled in the brick wall. Leakage around the sampler into the uptake can be stopped with asbestos packing. Figure 4 shows a good placing of the single-tube sampler in a horizontal tubular boiler.

The sampler is placed in the smoke box about 1 foot above the top row of tubes. If a sample is to be taken from any other place within the boiler setting, it is preferable that the open end of the sampler be placed in the center of the stream of gases.

PERFORATED-TUBE SAMPLER.

When it is desirable to obtain a sample that more nearly represents the composition of the entire stream of gases, a sampler of the type shown in figure 5 can be used.

This sampler consists of standard 1-inch iron pipe long enough to reach across the uptake or smoke box. The pipe is closed at both ends. The gas enters into this pipe through a number of $\frac{1}{16}$-inch holes drilled in opposite sides of the pipe about 6 inches apart, as shown in the figure. Through the bushing closing one end of the pipe is inserted $\frac{1}{4}$-inch iron pipe, which extends to the middle of the 1-inch pipe. This inside pipe is connected to the ejector and draws the gas out of the sampler. Such a sampler takes the gas the full width of the uptake at nearly uniform rate, and therefore the sample collected with it more nearly represents the entire stream of gas. Its drawback is that occasionally the small holes become stopped with soot and fine ashes. On this account the sampler must be taken out every few weeks and cleaned. Ordinarily if the gas analysis is used only as an aid to running the fires, it is doubtful whether the extra trouble of making this sampler and keeping it clean pays for the greater accuracy. If, however, the gas analysis is used for computing chimney losses the perforated sampler should be used, especially with fire-tube boilers.

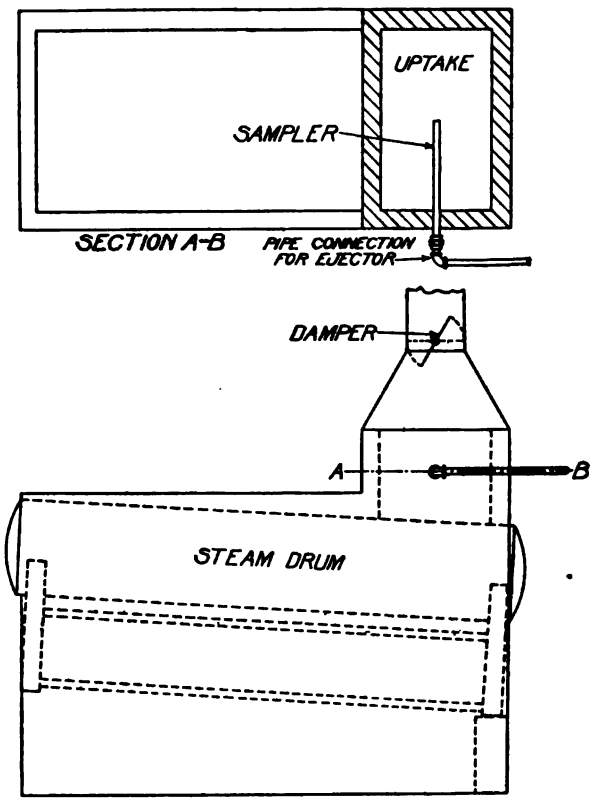


FIGURE 3.—Simple open-end sampler placed in the uptake of a water-tube boiler.

PIPE CONNECTIONS FOR SAMPLER.

The pipe connection is easiest made of standard ¼-inch iron pipe and cast-iron fittings. If possible the pipe should be so laid that there is a gradual drop toward the ejector. There should be no "pockets" in the pipe line, as these would fill up with condensed water vapor, which is always contained in the flue gases. If it is necessary

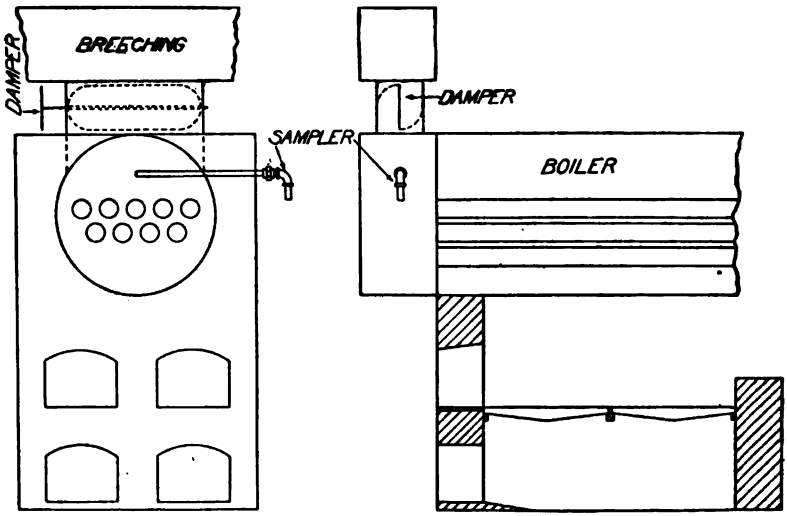


FIGURE 4.—Simple open-end sampler placed in the uptake of a horizontal return-tubular boiler.

to lower the pipe line at any place it is advisable that each low place be provided with a drain cock and a water trap, as shown in figure 6.

During the collection of a sample the drain cock is kept open, and the condensed moisture drains into the bottle. When the bottle is nearly filled, the drain cock can be closed and the bottle emptied. The connections on the water trap should be carefully put together, so that no air can leak into the pipe line. A rubber stopper should

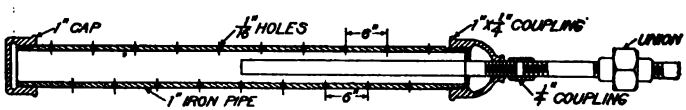


FIGURE 5.—Perforated-tube sampler.

be used in the flask in which the water collects; cork stoppers can not be kept air-tight.

The kind of fittings used at the ejector end of the pipe connection and the arrangement of these fittings are shown in figure 7.

The cocks best suited for the purpose are ¼-inch brass cocks, with male connection, corrugated hose end, and lever handle. Such cocks can be purchased from any dealer in gas fittings for about 20 to 25 cents apiece. The corrugated hose end makes good connection with

a ¼-inch rubber tubing. It is important that the cock delivering gas to the collecting bottles should be connected directly to the gas line as shown in figure 7; that is, no piping should be placed between the cock and the T in the gas line. Such piping would form a pocket of stagnant gas or air which would be drawn into the collecting bottle when the collection of a sample was started. All the joints should be well put together with graphite compound and painted with some thick paint to reduce as much as possible the chances of leakage. Rubber connections should not be painted.

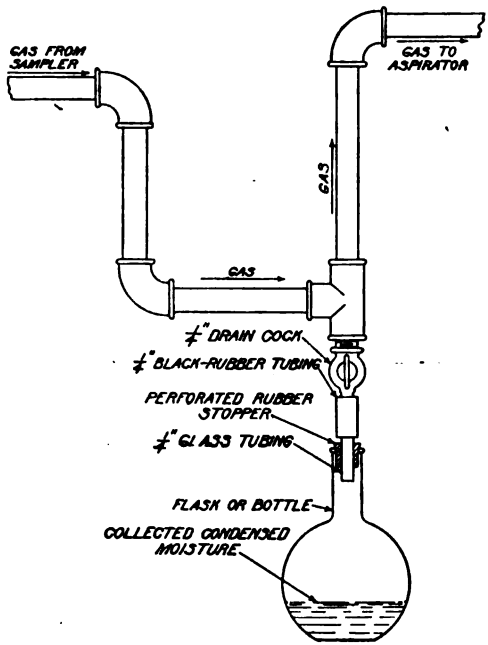


FIGURE 6.—Water trap placed at a "pocket" to drain water condensation.

EJECTOR.

The ejector works on the same principle as the ordinary steam injector used for feeding boilers. An efficient ejector can be made of ¼-inch fitting, as shown in figure 7. The only part that must be made specially is the nozzle. The nozzle consists of a ¼-inch nipple about 1½ inches long, made out of a solid piece of ½-inch round brass, with $\frac{1}{16}$-inch hole. The threading of the ends of the nipple and the drilling of the $\frac{1}{16}$-inch hole had better be done in the lathe, so as to have the hole in the center and the threading true with the hole. It is advisable not to drill the hole any larger than one-sixteenth inch,

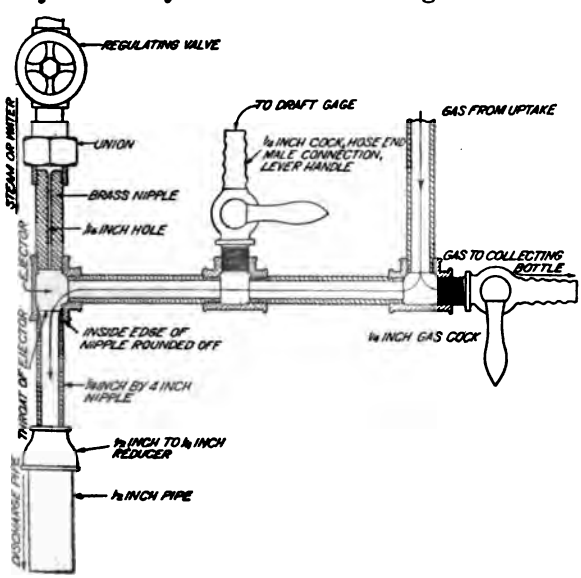


FIGURE 7.—Details of ejector and connections.

because too much steam would be used and the discharge pipe would have to be made of a large-size pipe; otherwise the steam will build up back pressure and reduce the vacuum caused by the ejector. The ¼-inch nipple forming the throat of the ejector should have the inside edge well rounded off, as shown in the figure. With this edge rounded off, the ejector operates more steadily and higher vacuum can be obtained.

In putting the ejector together care should be taken that the nozzle is threaded into the T straight, so that the stream of water or steam issuing from the nozzle hits the center of the throat. If the stream hits too far off the center the suction effect of the ejector might be thereby greatly reduced. With a well-made ejector, using steam, a suction sufficient to lift 3 or 4 feet of water column can be obtained. The suction can be adjusted to any lower value by a steam-regulating valve. A suction of 3 or 4 inches of water is usually sufficient. If water under about 50 pounds' pressure is used in the ejector, a suction of about 5 inches of water can be obtained. When water is used, the ¼-inch pipe forming the throat of the injector should be at least 12 inches long. If steam is used, the discharge pipe beyond the throat should be short and with as few elbows in it as possible. A union placed between the nozzle of the ejector and the regulating valve facilitates cleaning of the nozzle.

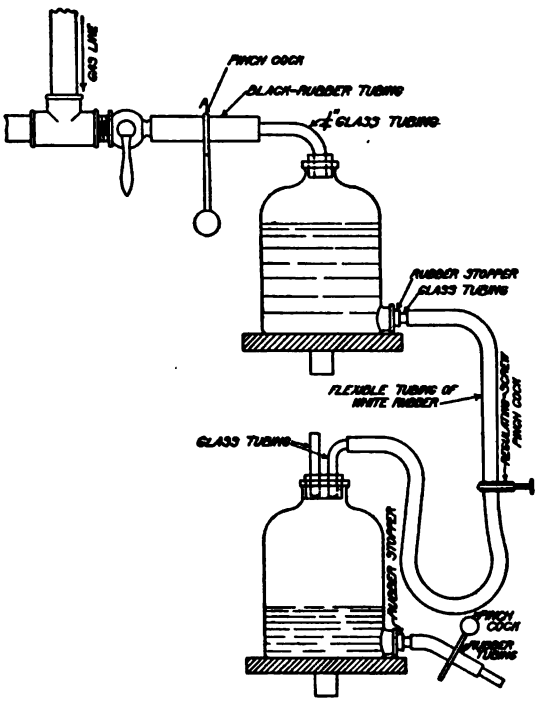


FIGURE 8.—Collecting bottles, showing their connections and arrangement when collecting gas.

COLLECTING BOTTLES AND THEIR CONNECTIONS.

The collecting bottles and their connections are shown in figure 8. Their trade name is "aspirator bottles." They have a side opening near the bottom. For collecting samples over a period of half a day bottles of 2 gallons capacity each are advisable. They can be purchased from any chemical supply or scientific-apparatus supply company at a price of about $1.50 to $2 each.

Both openings of each bottle are provided with well-fitting rubber stoppers, which should be ordered with the bottle. The stopper in the mouth of the bottle has two $\frac{1}{4}$-inch perforations; the stopper in the side opening has only one $\frac{1}{4}$-inch perforation. Cork stoppers should not be used, because they can not be kept gas-tight.

GLASS TUBING.

The glass tubing used in making the connections is $\frac{9}{32}$-inch outside and about $\frac{3}{16}$-inch inside diameter. About 20 feet of the tubing weighs 1 pound. Soft glass is better suited for this purpose, because the tube can be easily bent to any shape by heating to a dull-red temperature in a gasoline torch. While the tubing is being heated, it should be slowly revolved in the flame, so that it is heated uniformly around the circumference. If a bend at right angles is to be made, about 2 inches of the tube should be heated to a uniform dull-red heat and then removed from the flame before attempt is made to bend it. A wide flame is preferable to a pointed one for heating glass tubing that is to be bent. If the flame can not be made wide enough, the tubing should be moved back and forth sideways, so as to get sufficient length of the tubing heated. If only a short piece of the tubing is heated, a very sharp bend will be formed and the tubing will flatten down and nearly close the hole.

The tubing can be broken off at any desired place by filing a deep scratch on the glass and then exerting a slight pressure with the thumbs on the side opposite the scratch.

The glass tubing can be purchased from any chemical supply company at about 40 or 50 cents a pound. It comes in lengths of about 30 to 36 inches.

RUBBER TUBING.

The rubber connection between the upper bottle and the gas line should be made of $\frac{1}{4}$-inch black seamless unvulcanized rubber tubing of heavy walls. Such tubing can be purchased from any chemical supply company for about 15 cents a foot. The black rubber remains elastic and maintains gas-tight joints, and should be used wherever a gas-tight joint is required.

The connection between the two bottles can be of $\frac{1}{4}$-inch white-rubber tubing, light wall, cloth impression. Such tubing can be purchased for about 8 or 9 cents a foot. It is not so elastic as the black-rubber tubing and therefore it is not recommended for gas connections that must remain tight. However, for the water connection between the two bottles it is cheaper and even more durable than the black tubing.

TUBING CLAMPS.

Three clamps are needed for each set of collecting bottles. Of these the one used on the water connection between the two bottles should be a screw clamp (fig. 9). This type of clamp permits an easy adjustment of the quantity of water flowing from the upper bottle into the lower one. The other two clamps should preferably be of the spring type commonly called "pinch cocks" (fig. 9). This type can be used to better advantage where it is desired to have the rubber connection fully open or completely closed.

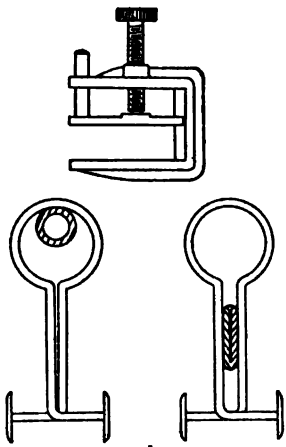


FIGURE 9.—Tubing clamps for closing rubber tubing. Top view shows a screw clamp to be used when fine adjustment of the flow through the tube is desired. Bottom views show a pinch cock for completely closing the rubber tubing.

The cost of the large screw clamp is about 15 cents; the price of the spring pinch cocks is about 6 cents each. They can be bought from any chemical supply company. The screw pinch cock should have the end of the screw covered with metal, so that the screw will not cut the rubber tubing.

PROCEDURE IN COLLECTION OF GAS SAMPLES.

DETAILS OF ARRANGING APPARATUS.

Figure 8 shows the arrangement of the bottles with connections made for collecting a gas sample. The upper bottle is connected to the corrugated hose end of the lever cock. This connection should be as short as possible. The lower bottle is placed 2 to 4 feet below the upper one. The greater this difference between their elevations, the more uniform is the rate of collecting the gases over long periods. The rubber-tube connection enters the lower bottle through the mouth and not through the side opening.

At the start the lower bottle is nearly empty. The upper one is completely filled with water; in fact, it is advisable to run the water into the rubber tubing as high as the pinch cock, so that all the gas or air will be expelled from the bottle. Care should be taken that the short piece of glass tubing does not protrude below the rubber stopper. If it should, a pocket of gas will be formed below the stopper and it will be impossible to expel this gas. All the pinch cocks as well as the lever cock on the gas line are shut. The ejector should run several minutes with a suction of 3 or 4 inches of water before the collection of the gas sample is begun. The suction is measured by the draft gage attached as shown.

To start collecting the gases the lever cock on the gas line and the pinch cock *A* are fully opened. The regulating screw pinch cock is

then partly opened and adjusted to any desired flow of water from the upper bottle into the lower one. The correct adjustment of the regulating cock can be made much easier by observation of the quantity of water dripping into the lower bottle than by observing the dropping of the water level in the upper bottle. When the water drips at the rate of three drops in 2 seconds, it takes about 6 hours to empty the upper bottle. As the water flows out of the upper bottle gas is drawn in from the gas line and takes the place of the water. The air in the lower bottle escapes through the short piece of glass tubing in the rubber stopper.

METHOD OF OBTAINING EFFECTIVE HEAD OF WATER.

The effective head causing the water to flow through the rubber connection between the two bottles is the difference between the elevation of the water level in the upper bottle and the elevation of the mouth of the lower bottle. This effective head is changed only by the drop of the water level in the upper bottle and not by the rise of the water level in the lower one. This relation holds only when the bottles are connected as shown in figure 8.

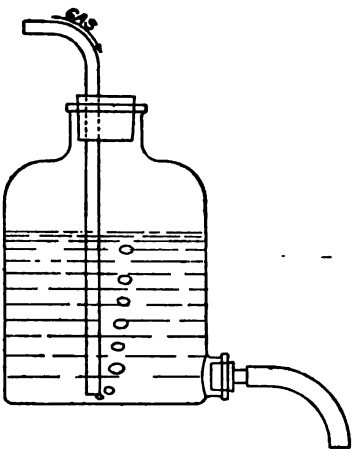


FIGURE 10.—Connections of the upper collecting bottle to maintain constant effective head. The gas bubbles through the water. This arrangement is not recommended.

If the connections were made to the side outlet of the lower bottle, the rise of the water level in it would also diminish the effective head. Variation in the effective head causes a corresponding variation in the rate of flow of water from the upper bottle into the lower one. Consequently the rate of collecting the gas sample is reduced as the effective head becomes smaller, although the adjustment of the regulating pinch cock remains the same. Therefore the variation in the effective head should be as small as possible. The greater the difference in the elevation of the two bottles the smaller will be the reduction in the rate of collecting the gas sample due to the drop of water level in the upper bottle. A difference of more than 2 feet gives fair results.

A constant effective head can be obtained by extending the glass tube so as to bring the gas nearly to the bottom of the upper bottle, and so as to let the gas bubble through the water, as shown in figure 10.

With this arrangement the effective water head is equal to the difference of elevation between the lower end of the glass tube and the mouth of the lower bottle and is of course constant. However, this

arrangement is not recommended, because as the gas bubbles through the water a considerable amount of the carbon dioxide (CO_2) may be absorbed by the water or given off, and an error amounting to several per cent may be introduced in the CO_2 determination. The seriousness of this error is shown by experimental results given in Table 9 on page 63.

EFFECT OF ABSORPTION OF CARBON DIOXIDE IN WATER.

Carbon dioxide is much more soluble in water than oxygen and nitrogen. The respective solubility of these gases is approximately 90, 2, and 1. Furthermore, water from a well or river is usually more nearly saturated with oxygen and nitrogen than with carbon dioxide. When the upper collecting bottle is freshly filled with water and flue gas is bubbled through the water, as shown in figure 10, a large part of the carbon dioxide is absorbed by the water. Thus if the flue gas contains 12 per cent of CO_2 when it enters the bottle, 6 per cent of the 12 may be absorbed by the water, so that the analysis of the collected sample may show only 6 per cent of CO_2. If several consecutive samples containing 12 per cent of CO_2 are collected, the water becomes saturated and the absorption of CO_2 is gradually reduced. Finally, the analysis of the last sample may show nearly 12 per cent. If, however, after the water has been saturated with flue gas containing 12 per cent of CO_2, a sample having only 6 per cent of CO_2 is collected, the water gives off some of the CO_2 absorbed from previous samples, and the analysis of the sample may show 9 per cent of CO_2.

That the error caused by the absorption of CO_2 by water is a serious one is shown by the experimental results given on pages 59 to 64. Even when the gas is collected over water, as shown in figure 8, some carbon dioxide may be absorbed or given off, although to a smaller degree. The absorption is larger if the gas sample is allowed to stand in the bottle a long time. Therefore, to reduce this error, the sample of gas should be analyzed immediately after the collection has been completed. The error due to this cause can be further reduced if salt brine be used instead of water. Carbon dioxide is less soluble in brine than in water. The absorption of CO_2 could be completely avoided if the bottles were filled with mercury instead of brine or water. However, the cost of mercury and the increased difficulty in handling the apparatus make the use of mercury inadvisable for the ordinary boiler-room or engine-room work.

DISPOSAL OF SURPLUS OF SAMPLE.

After a sample has been collected and a part of it taken for analysis, the remainder of the gas can be discharged into the gas line by raising the lower bottle and changing the connection to its side outlet, as

shown in figure 11. All the cocks, including the lever cock on the gas line, are fully opened.

The water flows back into the bottle connected to the gas line and forces the gas out through the discharge line. When the water has risen to the pinch cock *A*, all the cocks are closed and the bottles changed to the position shown in figure 8. The bottles are then ready for collecting another sample.

COLLECTION OF "GRAB" SAMPLE WITH ORSAT APPARATUS.

Sometimes it is desired to collect a sample of gas from various places within the setting over a short period of a few seconds. This can be done most easily by drawing the gas sample directly into the measuring burette of an Orsat apparatus, using an open-end tube sampler. Figure 12 shows a method of taking a "grab" sample from the third pass of a cross-flow water-tube boiler, the sampling tube being inserted through the cleaning holes.

Each time a sample for analysis is taken, the air should be removed from the sampler and the connections by drawing the air into the measuring burette and discharging it through the three-way cock.

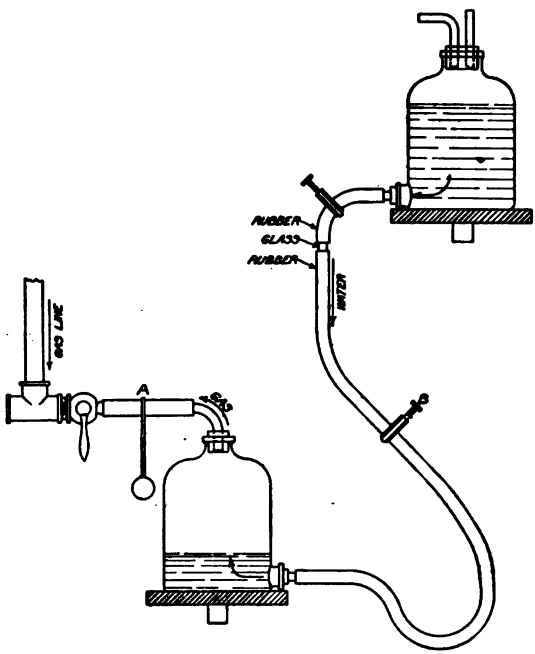


FIGURE 11.—Position of bottles when unused part of gas sample is being discharged and the bottle used for collecting sample is being filled with water. *A*, spring pinch cock; *B*, screw pinch cock.

The sampler should be made of small-size tubing, and the rubber connection should be as short as practicable in order that the volume of air they hold may be small and quickly drawn out. Ordinarily, filling the measuring burette two or three times suffices to remove the air. If only CO_2 is to be determined, $\frac{3}{16}$ inch or $\frac{1}{4}$ inch copper tubing is convenient for use as a sampler. One-quarter inch copper tubing holds approximately 1 cubic inch of gas for every 3 feet of its length, so that the measuring burette of a half-size Orsat apparatus at one filling empties about 9 feet of the tube. The capacity of $\frac{1}{4}$-inch standard iron pipe is about 1 cubic inch of gas for every 10 inches of its length, so that one filling of the measuring burette of a half-size

apparatus empties only about 30 inches of the pipe. These figures show the advantage of using small-size tubing as a sampler when the gas is collected directly in the Orsat apparatus.

The perforated-pipe sampler shown in figure 5 is not well adapted for this method of sampling because of its large gas-holding capacity. The manipulation of the Orsat apparatus when the sample is being drawn is described in the next chapter.

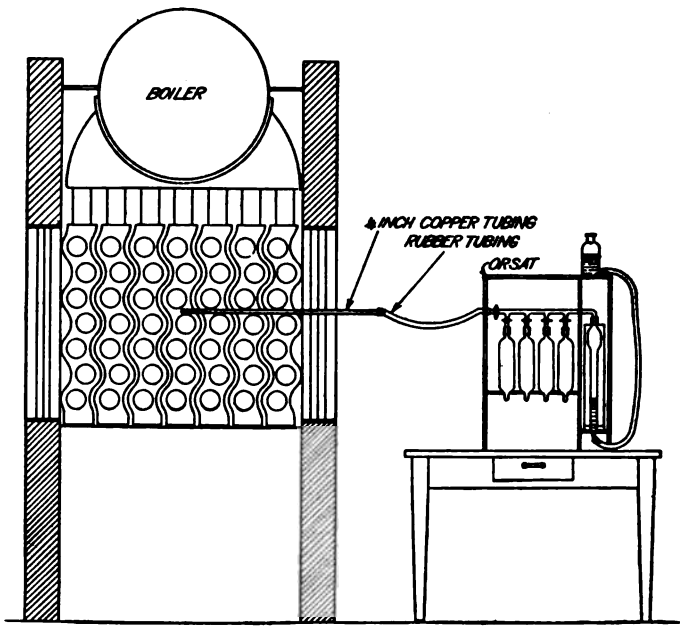


FIGURE 12.—Arrangement of apparatus for collecting "grab" sample from the third pass of a vertically baffled water-tube boiler.

ANALYSIS OF FLUE GASES.

Flue gas consists of carbon dioxide, oxygen, carbon monoxide, and nitrogen; but sometimes may contain small proportions of hydrogen and methane. Water vapor and a little sulphur dioxide are always present, but as regards boiler-room economy these constituents have little significance. Usually only the carbon dioxide, oxygen, and carbon monoxide are determined and the remainder is considered nitrogen. Frequently the carbon dioxide is the only constituent determined, this alone giving sufficient information as to the economic performance of the furnace.

The flue gases are usually analyzed with a portable apparatus commonly known as the Orsat, shown in figures 13 and 14. An analysis consists of successively absorbing the different constituents of the gas sample and of measuring the volume of the sample before and after each absorption.

DESCRIPTION OF ORSAT APPARATUS.

The essential parts of the Orsat apparatus are a measuring burette, three absorption pipettes, a leveling bottle, and a header, all of which are made of glass. These glass parts are inclosed in a compact wooden case.

MEASURING BURETTE.

The measuring burette is a cylindrical glass vessel graduated into 100 units, each unit being graduated into fifths. The measuring burette of a full-size Orsat apparatus has a volume of 100 c.c.; the volume of the burette of the half-size apparatus is 50 c. c. A volume of 16.38 c. c. is equal to 1 cubic inch. The burette is used for measuring the volume of gases during the process of analysis. It is inclosed in a water jacket which prevents sudden changes in temperature while the analysis is being made.

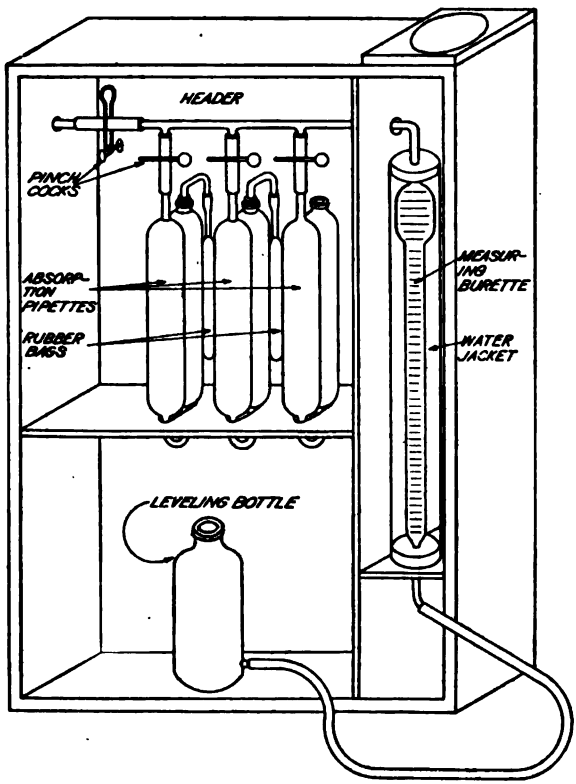


FIGURE 13.—Orsat apparatus with wire pinch cocks and rubber bags.

ABSORPTION PIPETTES.

The absorption pipettes are U-shaped glass vessels and contain solutions for absorbing the three principal constituents of the flue gas. The one nearest to the measuring burette contains potassium hyrdoxide solution for absorbing carbon dioxide; the second one contains an alkaline solution of pyrogallic acid for absorbing oxygen; and the third contains ammoniacal solution of cuprous chloride for absorbing carbon monoxide.

Two kinds of absorption pipettes are shown in figure 15.

The pipette with the opening and the ground-glass stopper near the top is not as good a design for general boiler-room work as the plain one. The stopper may become loose and the gas or solutions may leak out and cause trouble. One arm of the pipette contains

glass tubes to increase the surface of the liquid when in contact with the gas. To the other arm is attached a water seal or rubber bag to protect the solutions from deterioration by contact with air. The method of attaching the water seal or rubber bags is shown in figure 16.

The water seal requires an extra pipette, three No. 0 rubber stoppers with one hole, a glass T, and two right-angled glass bends. The joints should be made with ¼-inch black-rubber tubing. The rubber bags are attached by means of a rubber stopper and short piece of glass tubing. They should be air tight, as otherwise they may cause a great deal of trouble. After two or three months the rubber becomes hard and porous and the bags should be replaced by new ones. The water seal is more difficult to attach, but once attached to the apparatus it is permanent and gives no trouble. Only the solutions for absorbing oxygen and carbon monoxide need to be protected.

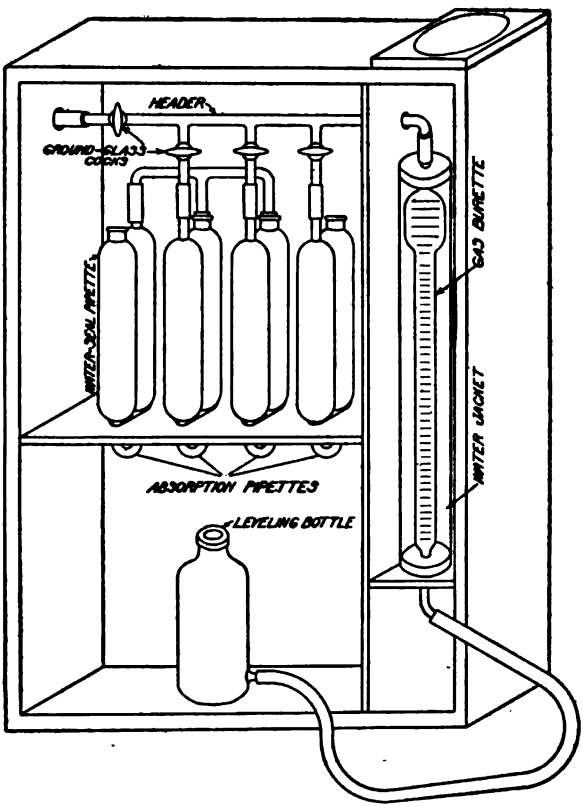


FIGURE 14.—Orsat apparatus with glass stopcocks and water seal.

LEVELING BOTTLE.

The leveling bottle, which is connected to the measuring burette with about 3 feet of black-rubber tubing, contains water. Lowering or raising the leveling bottle causes the water to act as a piston and draw gas into the measuring burette or force gas out of it into any absorption pipette. The water in the leveling bottle also is used to regulate the pressure on the gas when its volume is being measured.

HEADER.

The header is made of glass tubing of small bore. The measuring burette and absorption pipettes are attached to it with ¼-inch black-rubber tubing. All the joints must be gas tight. There is a glass stopcock on the header between each pipette and the burette, and at one end there is a three-way stopcock through which gas is taken into or discharged from the apparatus. The three-way cock has a spot of colored glass on it to indicate the direction of flow. Spring pinch cocks can replace the three stopcocks between the pipettes and the burette and thereby somewhat reduce the cost of the apparatus. The writers find the glass cocks more convenient to manipulate, but the glass cocks require greater care to keep them in good working condition. They must be kept lubricated with vaseline so that they will turn easily and will not stick. The vaseline should be applied in a thin film on the bearing surface of the valve and all excess avoided, for if too much is applied the small holes in the valves may become stopped.

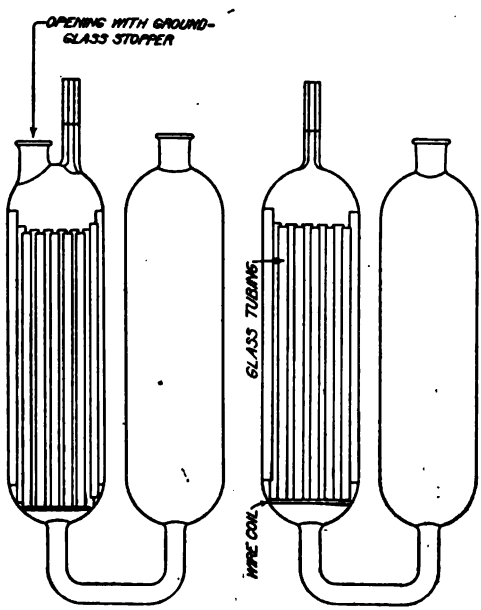


FIGURE 15.—Two kinds of absorption pipettes. The one without ground-glass stopper is the better design.

COST OF APPARATUS.

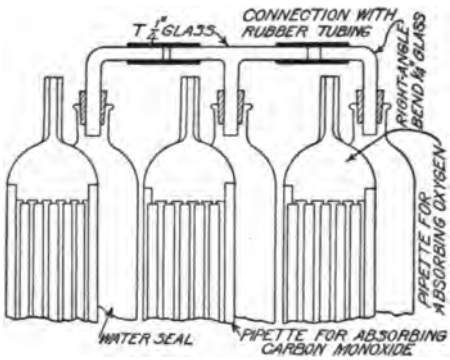
The half-size Orsat is lighter than the full size and therefore is preferable if the apparatus is to be carried from place to place. The apparatus can be purchased from any chemical-supply company. The cost of the full-size type with glass stopcocks is about $20, or with spring pinch cocks about $18. The half-size type correspondingly equipped costs about $18 and $16. Usually the apparatus is fitted with rubber bags to protect the solutions; if the water seal is wanted it must be specified when purchasing.

MANIPULATION OF ORSAT APPARATUS.

In a gas analysis the manipulation of the Orsat apparatus consists mainly of two operations—moving the gases into the different parts of the Orsat apparatus and measuring their volume.

MOVING THE GASES.

The moving of the gases is done with the water in the measuring burette and the leveling bottle. The water acts as a piston; when the leveling bottle is raised the water flows by gravity into the measuring burette and forces the gases into one of the absorption pipettes or out of the apparatus, depending on which valve is open. If the leveling bottle is lowered, the water flows by gravity from the burette into the leveling bottle and the gas is drawn from the apparatus into the burette. This manipulation in indicated in figures 17 and 18.



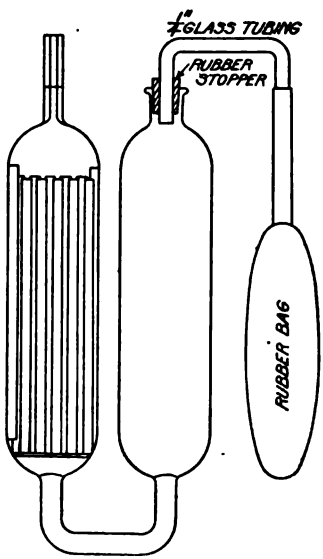


FIGURE 16.—Method of attaching water seal and rubber bags for protection of the solutions from air.

In the illustrations the movement of water and gases is indicated by the arrows. Figure 17 shows the process of drawing the gas sample from the collecting bottle into the Orsat apparatus, the water flowing out of the burette into the leveling bottle. The three-way cock on the Orsat apparatus is opened in such a way that the gases flow from the collecting bottle into the measuring burette; the valves on all the absorption pipettes are closed.

When gas is being drawn from the absorption pipette, care should be taken not to draw the solution into the valve or to run the solution into the water in the measuring burette. The solution rises slowly as long as the level is in the wide part of the pipette, but as soon as it reaches the small bore of the neck it rises rapidly, and before an inexperienced operator realizes what is happening part of his solution is drawn into the measuring burette. The best way to avoid such accidents is to operate the Orsat apparatus as shown in figure 19. The leveling bottle is manipulated with the right hand while the rubber-tube connection is held between the thumb and first finger of the left hand.

If pressure be exerted on the rubber tubing, the flow of gas can be so reduced that it can be stopped easily with the top of the solution at any desired point in the neck of the pipette. When the solution has been brought to the point desired, the analyst may hold it there by pinching the rubber tubing, the leveling bottle being placed on the stand so as to leave the right hand to manipulate the valve. The same manipulation should be used when the gases are being forced into the absorption pipettes.

MEASURING VOLUME OF GASES.

The measurement of the volume is the most important operation in the analysis of gases. During any one analysis all measurements of the gas volume must be made under constant temperature and pressure.

A rise in temperature increases the volume of the gases. It is to avoid the change in the temperature that the measuring burette is water-jacketed. To further decrease the possibility of temperature changes, the Orsat apparatus should be in a place free from draft or heat radiation from the boiler or engine.

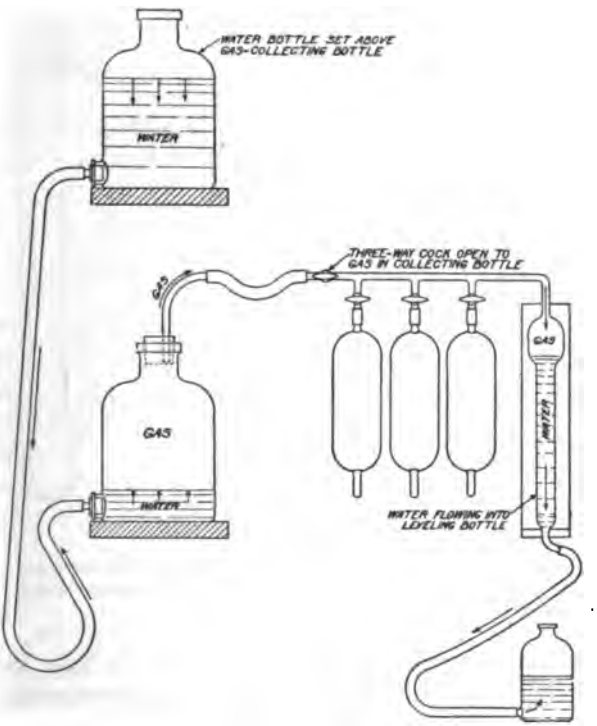


FIGURE 17.—Relative position of collecting bottle, Orsat apparatus, and leveling bottle, and their connections when gas is being drawn into the burette.

A change in pressure changes the volume of gases. Inasmuch as the atmospheric pressure changes little and any change takes place slowly, the volume of gases is conveniently measured under atmospheric pressure. The gas in the measuring burette is brought under atmospheric pressure by holding the leveling bottle at such position that the water level in the measuring burette and that in the leveling bottle are at the same height; that is, so that a horizontal line will pass through both levels. The position of the leveling bottle when the volume of the gases is read is shown in figure 20. When the reading is taken, the rubber tubing must be free from kinks.

The necessity of bringing the two levels to the same height before the volume is read can be appreciated by noting that raising or lowering the leveling bottle will give almost any desired volume in the measuring burette.

Another precaution that should be taken before the volume is read is to allow the water to drain down the sides of the burette for the same length of time. Under ordinary conditions half of a minute is enough. The inside of the measuring burette should be kept clean, in order that the water may drain well.

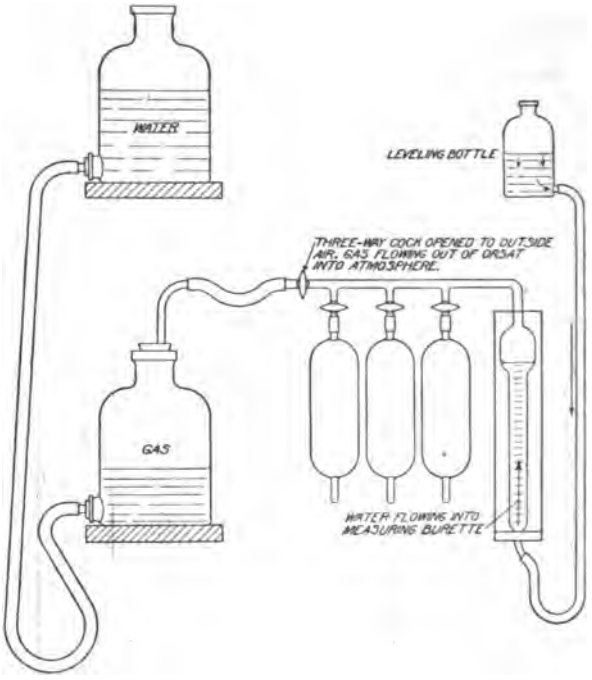


FIGURE 18.—Relative position of leveling bottle and the Orsat apparatus when gas is being expelled from the apparatus. The three-way cock is opened to the atmosphere.

TESTING FOR LEAKS.

Careful attention should be given joints on the Orsat apparatus. In making connections the ends of the glass tubing should be brought close together. The rubber joints must be perfectly tight. To test for leaks the measuring burette is about half filled with air and all the stopcocks are closed. The leveling bottle is then lowered about 2 or 3 feet, the air inside the burette being thus placed under a reduced pressure. If the water in the burette falls to a certain point and then remains stationary, there is no leak. If it continues to fall slowly, there is a leak, which must be stopped before the analysis goes further.

PREPARING ORSAT APPARATUS FOR ANALYSIS.

Before an analysis is begun each solution must be brought to the mark on the stem of the pipette and the corresponding valve in the header closed. Any gas that has been drawn into the measuring burette is expelled and the water is forced into the small-bore neck of the burette. The apparatus is then ready for use in an analysis.

PROCEDURE IN MAKING THE ANALYSIS.

CLEANING THE APPARATUS.

To take gas into the apparatus the end of the header is connected to the gas supply, such as a collecting bottle. The gas is drawn in by lowering the leveling bottle, with the three-way cock opened to the gas supply, as shown in figure 17. It is forced out by raising the leveling bottle with the three-way cock opened to the outside air, as shown in figure 18. Before a part for analysis is retained three or four burettes of gas are drawn into and forced out of the apparatus. The apparatus is thus cleaned of all the residue from the previous analysis, or of air, and a true sample of the flue gas to be analyzed can be obtained.

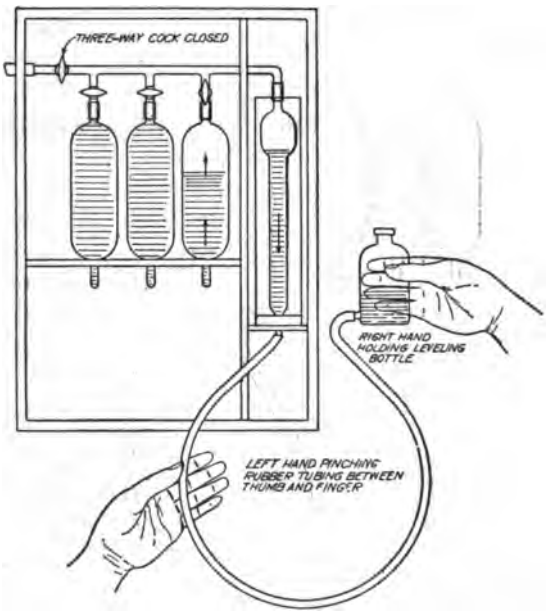


FIGURE 19.—Manipulation of Orsat apparatus when gas is being drawn out of absorption pipette. Left hand throttles the flow of water, thus controlling the flow of gas from the absorption pipette; right hand holds the leveling bottle.

MEASURING THE SAMPLE.

After three or four burettes of gas have been rejected, a burette of gas is drawn into the apparatus and the three-way cock is closed. The gas is placed under a slight pressure by raising the leveling bottle until the water is above the zero mark. The rubber tubing is then pressed between the thumb and first finger of the left hand and the leveling bottle is placed below the lower end of the measuring burette. The pressure exerted with the left hand on the rubber tubing is slowly released and the water allowed to fall to the zero mark. It is held at this point by pinching the rubber tubing, while the three-way cock is opened to the outside air for a few seconds and closed. When the pressure on the rubber tubing is released and the water in the leveling bottle is held at the same level as the water in the burette, the level line should pass through the zero mark. If the line of common level does not pass through zero mark, the manipulation just described must be repeated.

CARBON DIOXIDE DETERMINATION.

When the volume of gas has been adjusted so that the water level passes through zero, the gas is forced into the pipette, containing potassium hydroxide solution. This is done in the manner indicated in figure 19, the leveling bottle being raised above the Orsat apparatus so that the water flows into the burette.

The rubber tubing is pressed between the thumb and first finger of the left hand, the leveling bottle placed on top of the Orsat apparatus, and the valve leading to the first pipette is opened. The pressure of the fingers on the rubber tube is released, allowing the water to run from the leveling bottle into the burette and forcing the gas into the pipette. When the water in the burette reaches the small-bore neck the leveling bottle is lowered and the gas is drawn back into the burette, care being taken not to draw the solution into the valve. The flow of gas can be nicely regulated with the pressure on the rubber tubing as described in connection with figure 19. This operation is repeated three times, the gas being slowly forced into and drawn out of the pipette.

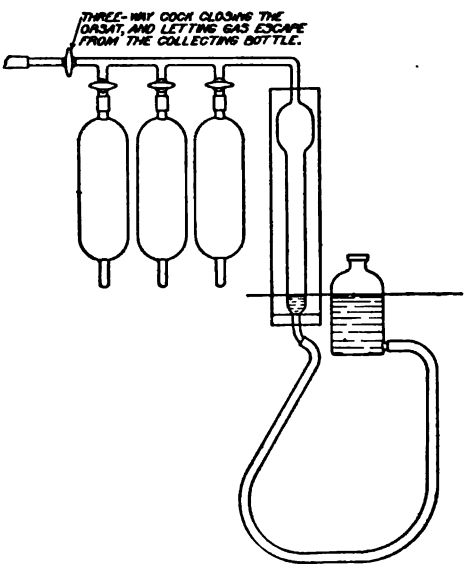


FIGURE 20.—Position of leveling bottle when gas volume is read. Water in measuring burette and leveling bottle at the same level.

After the gas has been drawn out of the pipette the last time the solution is brought to the mark on the neck and the stopcock is closed. The volume is measured by bringing the water in the leveling bottle to the water level in the measuring burette, as shown in figure 20. The gas is then forced again into the pipette and drawn back into the burette and the volume measured once more. If the two readings are the same, all of the carbon dioxide has been absorbed; if not, the operation is repeated until two readings are the same. The reduction in the volume of gas is due to the absorption of the carbon dioxide by the solution and is the measure of the amount of this constituent in the gas. It is well to remember that when the gas is drawn out of the pipette the solution should always be brought to the same mark on the stem and the valve closed before the volume is measured.

The solution can be brought to the mark with a nicety by throttling the water in the rubber tubing with the fingers of the left hand. In fact the transferring of the gas from the burette to the pipettes and back again can be done a great deal easier if the left hand is held constantly on the tubing, ready to throttle the flow of water whenever an exact adjustment of the levels is required. The manipulation is that indicated in figure 19. Care should be taken not to run water into the header, and particularly not to draw solution into the stopcocks.

If the glass tubes in the pipettes are not properly arranged, gas may pass through them into the other arm of the absorption pipette and be lost. The tubes should be watched when the gas is being passed into the pipette, and all gas loss avoided.

OXYGEN DETERMINATION.

After all the carbon dioxide has been taken out, the remaining gas is forced into the second pipette containing an alkaline solution of pyrogallic acid, which absorbs the oxygen. The gas is moved back and forth as in the absorption of carbon dioxide. Oxygen is absorbed much slower than carbon dioxide; therefore the gas must be passed into and out of the pipette a greater number of times. The absorption should be continued until two successive measurements are the same. The contraction in volume is the amount of oxygen in the gas.

CARBON MONOXIDE DETERMINATION.

Carbon monoxide is absorbed in an ammoniacal solution of cuprous chloride. After all the carbon dioxide and oxygen have been removed the carbon monoxide in the remainder of the gas is absorbed in the third pipette in the same manner as in the preceding determinations. Accurate determination of the carbon monoxide is difficult. Cuprous chloride solution, after being used for some time, will not remove all the carbon monoxide. Moreover, if gas containing no carbon monoxide is passed into a solution that has absorbed carbon monoxide previously some of it will be given off, and an increase in volume will result. To obtain accurate results the solution must be renewed frequently.

EXAMPLES OF ANALYSIS.

Analysis is started with the measuring burette filled with gas to the zero point. The gas is forced into and drawn out of the first pipette three times. The volume measures, say, 5.2. The gas is forced into and drawn out of the pipette once more. The volume is the same as before; therefore all the carbon dioxide has been absorbed. The contraction, or the carbon dioxide absorbed, is 5.2. The remaining gas is forced into and drawn out of the second pipette five times. The

volume is found to be, say, 19.4. The gas is forced into and drawn out of the pipette twice more, and the volume is found to be, say, 19.6, showing that all the oxygen had not previously been absorbed. If, after two more passages, the volume remains 19.6, all the oxygen has been removed. The contraction is 19.6 minus 5.2, or 14.4, which is the amount of oxygen in the gas. The remaining gas is forced into and drawn out of the third pipette three times. The volume is measured and no contraction is observed; therefore no carbon monoxide is present.

An analysis is recorded in percentage by volume. As mentioned previously, the measuring burette of an Orsat apparatus is graduated to 100 units, the units being further graduated to fifths. If the sample fills the burette to the zero mark, the contraction can be read in terms of percentage by volume. If the sample of gas does not fill the burette to the zero mark, the contraction divided by the volume of gas taken for analysis and multiplied by 100 equals the percentage by volume. An example will illustrate: The volume of gas taken for analysis is 49.0 units. After carbon dioxide has been absorbed the volume is 44.2 units. The contraction is $49.0-44.2=4.8$ units. $\frac{4.8}{49.0}\times 100=9.8$ per cent of carbon dioxide. After the oxygen has been absorbed the volume is 39.8 units. The contraction is $44.2-39.8=4.4$ units. $\frac{4.4}{49.0}\times 100=9.0$ per cent of oxygen. It is much better, if possible, to fill the measuring burette to zero point.

PRECAUTIONS TO BE TAKEN TO OBTAIN ACCURATE RESULTS.

Accurate results can be obtained only by close attention to details. The apparatus must be perfectly tight. A test for leaks should be made each day before an analysis is begun. The constituents must be absorbed in the proper order—first, carbon dioxide; second, oxygen; and third, carbon monoxide. The solutions for oxygen and carbon monoxide absorb carbon dioxide and the solution for carbon monoxide absorbs oxygen also; therefore, each constituent must be removed completely before absorption of the next is begun. The solutions should be replaced by fresh ones when the absorption becomes slow. All measurements of volume must be made under the same pressure. Changes in temperature during an analysis should be avoided.

PREPARATION OF SOLUTIONS.

The absorbing agents employed are solutions that are prepared by dissolving a weighed quantity of chemicals in a measured volume of water. If no balance and graduate are available with which the materials can be weighed and measured, the quantities can be approxi-

mated in cubic inches with fair accuracy. However, it is advisable to provide an 8-ounce glass graduate, which will be found useful in measuring liquids. It can be bought from any chemical supply house for about 40 cents.

POTASSIUM HYDROXIDE SOLUTION FOR ABSORBING CARBON DIOXIDE.

For the preparation of the solution for absorption of carbon dioxide potassium hydroxide not purified by alcohol should be used. It can be bought in sticks about five-sixteenths of an inch in diameter. A stick 5 inches long weighs approximately one-half ounce. Three hundred and thirty grams of potassium hydroxide, about 14 ounces, or twenty-eight 5-inch sticks, are dissolved in 1,000 cubic centimeters, about 34 fluid ounces or 61 cubic inches, of clear water.

The solution can be made in a bottle or in an open vessel. If a bottle is used, the potassium hydroxide should be added to the water slowly to prevent breaking the bottle by the heat produced. If an open vessel is used, the water can be poured into the potassium hydroxide at once. The solution should be cooled before it is transferred to the bottle. If a precipitate forms, as is usually the case, it should be allowed to settle and the clear liquid poured off without disturbing the sediment.

Potassium hydroxide, thus prepared, can be kept in a rubber-stoppered bottle and used as a stock solution for carbon dioxide determinations and for making alkaline pyrogallic acid solution. A pipette full can be used for about 150 determinations of carbon dioxide.

ALKALINE PYROGALLIC ACID SOLUTION FOR ABSORBING OXYGEN.

The alkaline pyrogallic solution for absorbing oxygen is prepared by dissolving in the graduate or other glass vessel 10 grams (about one-third of an ounce or 2½ cubic inches) of pyrogallic acid in 25 cubic centimeters (about 1 fluid ounce or 2 cubic inches) of water. This is poured into the second pipette, and potassium hydroxide solution from the stock bottle is added until both arms of the pipette are a little more than half filled. The two solutions should be mixed in the pipette and the seal attached immediately to prevent absorption of the oxygen from the air. The mixing is done by raising and lowering the leveling bottle a few times and running gas into and out of the pipette.

Alkaline pyrogallic acid absorbs oxygen rapidly at first, but as oxygen is absorbed the speed of absorption decreases. The best results are obtained by renewing the solution whenever the absorption of oxygen becomes slow. One filling of the pipette can be used for about 40 determinations of oxygen in flue gas.

AMMONIACAL CUPROUS CHLORIDE SOLUTION FOR ABSORBING CARBON MONOXIDE.

The chemicals required for the preparation of a solution for the absorption of carbon monoxide are cuprous chloride, ammonium chloride, both small crystals, and ammonium hydroxide (ammonia water). The ammonia water should be clear and have a specific gravity of 0.91. The article sold in stores as household ammonia should not be used. It is best to purchase all the chemicals required from a chemical supply house.

A stock solution can be prepared best in a 2-quart bottle, which should be thoroughly cleaned before use. To 750 cubic centimeters (about 25 fluid ounces or 46 cubic inches) of water in the bottle is added 250 grams (about 9 ounces or 30 cubic inches) of ammonium chloride. The mixture is shaken until the salt crystals are dissolved. The ammonium salt dissolves readily and only a little shaking is necessary. To this solution is added 200 grams (about 7 ounces or 12 cubic inches) of cuprous chloride. The cuprous chloride dissolves slowly and the mixture should be shaken from time to time to aid solution.

Often the cuprous chloride does not all dissolve, and some of it settles on the bottom of the bottle. When the solution is being used, only the liquid should be poured off, without disturbing the sediment to any extent. A few pieces of clean scrap copper or copper wire placed in the bottle will help to keep the cuprous chloride reduced. If the bottle is tightly stoppered the solution can be stored indefinitely.

In preparing the stock solution for use enough is poured into the graduate or other glass vessel to fill one arm of the pipette. To this measured quantity is added slowly ammonium hydroxide (ammonia water). When the ammonia is poured in, a white flaky precipitate at first forms in the solution but disappears as more ammonia is added, and the solution becomes dark blue. The mixture should be stirred while the ammonia is added, and the amount of ammonia should be just enough to dissolve the precipitate completely.

Approximately one volume of ammonia is required for three volumes of the stock solution. If too much ammonia is added the ammonia vapor will increase the volume of the gas sample after contact with the solution. When all the precipitate has been dissolved the solution should be poured immediately into the pipette, as exposure to air weakens the solution. After the pipette has been filled according to the directions given in the section headed "Filling and Attaching Pipettes," any of the solution that may be left should be thrown away and not returned to the stock bottle.

A fresh solution of cuprous chloride, if given time enough, will remove all of the carbon monoxide from the gas mixture, but a solution

that has absorbed considerable carbon monoxide will not remove all of this gas from a gas mixture and may even give off carbon monoxide. Therefore the operator must know the condition of the solution in order to be certain of results.

The length of time the solution can be used with good results will depend on the volume of carbon monoxide to be determined. For small amounts of carbon monoxide a solution that has not previously absorbed much carbon monoxide should always be used. Because of the small amount of carbon monoxide ordinarily present in flue gas and the difficulty of making an accurate determination, it is not advisable to make this determination regularly in boiler-room work, especially if the CO_2 content of the gases is low.

FILLING AND ATTACHING PIPETTES.

To clean and fill a pipette it should be removed from the stand. The required quantity of solution is poured in the open end of the pipette and the latter then fixed in position on the stand. The solution should fill both arms a little more than half full, and when drawn up to the mark on the stem of the pipette it should stand in the rear arm to a depth of about 1 inch. The front arm of the pipette is attached to the header by a piece of black rubber tubing about 1¼ inches long. To make the connection the rubber tubing is slipped entirely over the small end of the pipette, the glass tubes are brought together, and the rubber tubing is worked carefully upward until half of it is on the glass tube from the header and half remains on the pipette. Wetting the inside of the rubber causes it to slide easily on the glass.

The solutions are drawn up to the mark on the stem of the pipette by lowering the leveling bottle before beginning an analysis. The seal should be attached to the pipettes as soon as they are filled in order to protect the solutions from the air. When the joints on the Orsat apparatus must be broken it is best to cut the rubber tubing, because after a short time the rubber sticks to the glass and does not slide easily.

Care should be taken not to get the solutions on the hands and clothes, as they are strongly alkaline and will injure the clothes. When handling potassium hydroxide sticks cotton gloves or a piece of cloth can be used to protect the hands.

CARE OF ORSAT APPARATUS.

The operator will save time and expense and prevent many troublesome difficulties by taking good care of the Orsat apparatus.

If the ground-glass surfaces of stop cocks are allowed to stand without cleaning, they will become cemented together by alkaline

solutions, and the cocks can not be operated. The only remedy is to keep the stopcocks free from alkali and lubricated with a thin film of vaseline. If too much vaseline is used, the openings in the cocks and capillary tubes become stopped with the excess. A properly lubricated stopcock has the appearance of a single piece of thick glass.

If a solution is accidently drawn into a stopcock, the cock should be removed at once and the surfaces wiped clean with a cloth or piece of soft paper, and lubricated with a thin film of vaseline. If necessary the header should also be removed and washed free from alkali.

The water in the burette and leveling bottle should be saturated with flue gas and should be changed as often as it becomes dirty. If the water becomes alkaline by solution being drawn into the header and washed into the burette it should be changed at once. If this is not done carbon dioxide will be absorbed by the alkaline water and the percentage of CO_2 indicated by the analysis will be low.

The joints made with rubber tubing should be examined and the apparatus tested for leaks before work is started. This is especially necessary when the Orsat apparatus is not used frequently.

The apparatus should be kept clean. If the walls of the burette and water jacket are dirty or dirty water is used, accurate measurements can not be made.

Skill in the use of the Orsat apparatus requires practice. However, an inexperienced but careful operator, after making about a dozen analyses can obtain results that are accurate enough for all ordinary requirements of boiler-room work.

USE OF GAS ANALYSIS IN REDUCING BOILER-ROOM LOSSES.

If gas analysis is intelligently applied to boiler furnaces it should prove itself an effective means of reducing boiler-room losses, for it furnishes information as to the magnitude and the cause of large chimney losses. An analysis for CO shows the approximate losses due to incomplete combustion. When efforts are made to reduce these losses, gas analysis shows how effective the applied remedies are.

Figure 21 is a graphic representation of the power-plant losses in an average industrial plant of 1,000 to 2,000 horsepower. The process of power generation, its transmission and utilization, is shown as a stream of heat starting with the coal fired under the boiler and ending in the power utilized in a cotton mill. The losses are shown as streams branching off to one side from the main stream. The first five side streams represent the boiler-room losses, and together amount to 43 per cent of the heat in the coal fired. The second loss, which is the heat carried away by the dry chimney gases, is the largest of boiler-room losses. It amounts to 26 per cent of the total heat in coal fired and is much larger than all the other boiler-room losses put

together. It is this loss that, by the intelligent interpretation of gas analysis, can be reduced to 15 or even 10 per cent without increasing appreciably the loss from incomplete combustion.

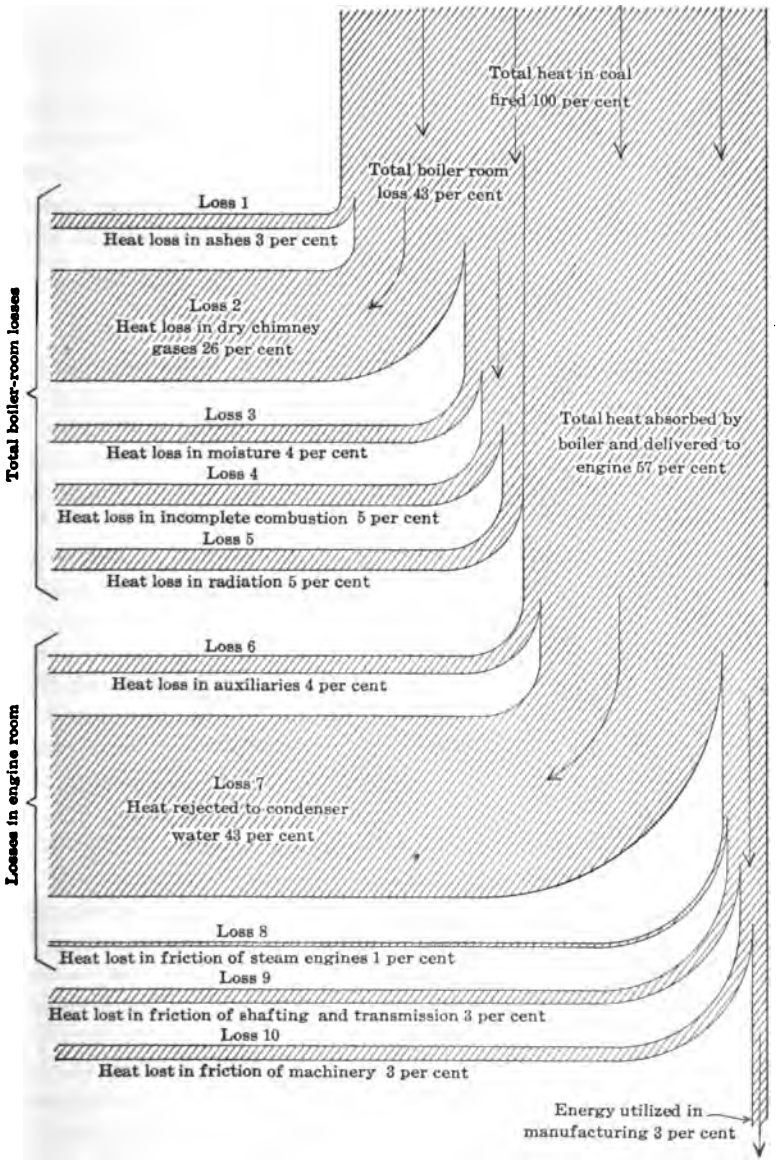


FIGURE 21.—Graphic representation of losses in an average industrial power plant having 1,000 to 2,000 horsepower capacity. The branches turning to the left from the main stream represent the losses.

For the complete combustion of 1 pound of coal in the ordinary boiler furnace about 15 pounds of air is necessary. This air is taken into the furnace at atmospheric temperature and leaves the boiler at

a temperature of about 500° F. higher. It carries along with it all the heat that has been absorbed in raising its temperature 500° F. Each pound of air or of the products of combustion absorbs approximately one-fourth of a heat unit per degree of temperature rise. Therefore, with a temperature elevation of 500° F. each pound absorbs $\frac{500}{4}$, or 125, heat units.

If 15 pounds of air is used to burn 1 pound of coal the products resulting from the combustion weigh 16 pounds. The quantity of heat carried out with the chimney gases for each pound of coal burned then is 16 times 125, or 2,000 , heat units. If 1 pound of coal as fired contains 14,000 heat units, the heat carried out with the chimney gases constitutes $\frac{2000}{14000}$, or 14.3 per cent, of the total heat in the coal.

If instead of using 15 pounds of air to burn 1 pound of coal, the fireman uses 31 pounds of air, the products of combustion weigh 32 pounds, and the heat loss in the dry chimney gases is 32 times 125, or 4,000, heat units, or 28.6 per cent of the total heat in the coal fired. Thus it can be shown that the chimney losses increase almost directly with the amount of air used for the combustion of coal.

Besides increasing the chimney losses, the use of a large excess of air reduces appreciably the horsepower that can be developed with a given boiler installation. This feature is an important one in case the boiler plant is heavily loaded.

It is apparent then, that if the chimney losses are to be low, and the horsepower developed by the boiler high, the weight of air used in the combustion of coal must be kept as low as completeness of combustion will permit; 15 pounds of air to 1 pound of coal, if properly introduced into the furnace and with careful firing gives practically complete combustion in most boiler furnaces, but an engineer should find out how much air his fireman is using and whether he is getting complete combustion. It is just this information that the analysis of flue gases furnishes.

Combustion of coal is a chemical combination of its carbon and hydrogen with the oxygen of air, the products of combustion are carbon dioxide (CO_2) and water vapor (H_2O) respectively. Air consists approximately of 20 per cent of oxygen and 80 per cent of nitrogen by volume. If all the oxygen that enters the furnace were used in combustion, the analysis of the products would show about 81.5 per cent of nitrogen and 18.15 per cent of carbon dioxide. The percentage of carbon dioxide would not be as high as the percentage of oxygen in the air admitted into the furnace because some of the oxygen combines with the free hydrogen of coal and forms water

vapor which is condensed and therefore does not appear in the analysis of gases.

If only one-half of the air entering the furnace is used in the combustion of coal the analysis of the products shows about 9 per cent of carbon dioxide and 10 per cent of free oxygen—that is, about half of the oxygen appears in the form of CO_2 and half as O_2. The CO_2 is not exactly equal to the O_2, because a small part of the oxygen used in combustion combines with the hydrogen of the coal and is condensed as water. Thus the CO_2 content of the flue gases shows what proportion of the air entering the furnace is actually used in the process of combustion and the oxygen content shows what proportion is in excess of the amount actually used.

CALCULATION OF THE WEIGHT OF GASES.

From the analysis the weight of the gases (W) per pound of coal burned can be computed from the following formula:

$$(1)\quad W=\frac{11\ CO_2+8O_2+7(CO+N_2)}{3(CO_2+CO)}\times\frac{\text{per cent of carbon in coal}}{100}$$

Or, as $CO_2+O_2+CO+N_2=100$ always, with the simple Orsat analysis under consideration,

$$(2)\quad W=\frac{(4\times CO_2+O_2+700)}{3(CO_2+CO)}\times\frac{\text{per cent of carbon in coal}}{100}$$

In applying equations *1* and *2* the percentages of CO_2, O_2, CO and N_2 in a given flue gas are to be substituted for the chemical symbols.

The following examples show the use of these equations:

EXAMPLE A.

Suppose that the analysis of a given flue gas shows the following results:

	Per cent.
CO_2	7.0
O_2	12.0
CO	.2
N_2	80.8

Suppose the carbon content of the coal burned to be 85 per cent.

Substitution of the analytical results in equation *1* gives:

$$\frac{11\times7.0+8\times12.0+7(0.2+80.8)}{3(7.0+0.2)}\times\frac{85}{100}=\frac{740}{21.6}\times0.85=29.08 \text{ pounds of gases per pound of coal.}$$

Substitution of the analytical results in equation *2* gives:

$$4\times7.0+12.0+700\times\frac{85}{100}=\frac{740}{21.6}\times0.85=29.08 \text{ pounds of gases per pound of coal.}$$

Both equations give the same result; however, equation *2* is the simpler one to use.

EXAMPLE B.

Suppose that the analysis of a given flue gas shows the following results:

	Per cent.
CO_2	12.0
O_2	7.0
CO	0.4
N_2	80.6

Suppose the carbon content of the coal burned to be 85 per cent.

Substitution of the analytical values in equation *1* gives:

$$\frac{11\times12.0+8\times7.0+7(0.4+80.6)}{3(12.0+0.4)}\times\frac{85}{100}=\frac{755}{37.2}\times0.85=17.27$$ pounds of gases per pound of coal.

CALCULATION OF CHIMNEY LOSSES.

From the weight of gas per pound of coal the chimney losses can be computed by using the following equation:

(*3*) $W\times0.24\times(T-t)$=heat carried away with dry chimney gases expressed in British thermal units.

Where W=weight of gases in pounds per pound of coal as computed by equations *1* and *2*.

0.24=specific heat of gases.

T=temperature of gases leaving boiler, in °F.

t=temperature of air entering furnace, in °F.

If it is desirable to express this loss in percentage as given in figure 21, the value obtained by equation *3* is divided by the number of British thermal units in one pound of coal and multiplied by 100.

Thus in examples A and B if the temperature of air entering the furnace is 75° F., the temperature of the gases leaving the boiler 600° F., and the heat in the coal burned 13,500 British thermal units, the losses are:

$$(a)\quad \frac{29.08\times0.24\times(600-75)\times100}{13,500}=27.1 \text{ per cent.}$$

$$(b)\quad \frac{17.27\times0.24\times(600-75)\times100}{13,500}=16.1 \text{ per cent.}$$

In example A, with the CO_2 content in the flue gases 7.0 per cent, the loss is 27.1 per cent, and in example B, with 12 per cent of CO_2 in the flue gases, the loss is only 16.1 per cent of the heat in the coal, the difference being 11 per cent in favor of the furnace represented in example B having the high percentage of CO_2.

The two examples show that there is a definite relation between the percentage of CO_2 in the flue gases and the chimney losses represented in figure 21 by loss 2. This relation is shown in figure 22 in which the horizontal distances represent the percentages of CO_2 in flue gases and the vertical distances (the ordinates) represent the heat losses in dry chimney gases. Each of the four curves gives the heat losses for one temperature difference between the flue gases and the air entering the furnace, as indicated by the figures at the right of the curves.

The curves are computed for coal having 82 per cent of carbon and a heat value of 13,500 British thermal units; that is, a good grade of bituminous steam coal.

The following examples show how figure 22 can be used for computing dry chimney gas losses, when the percentage of CO_2 and the temperature of the flue gases and of the boiler-room air are determined.

EXAMPLE A.

CO_2 in flue gases =6.0 per cent.
Temperature of flue gases =600° F.
Temperature of boiler-room air=75° F.

The difference between the flue gas and the boiler-room temperature is 600°−75°=525° F. Therefore the second curve from the top, designated by the figures 525° F., should be used for this example. Take the vertical line starting from the point of 6.0 per cent of CO_2 on the scale at the bottom of the chart and follow it to the second curve from top; from the intersection point on this curve follow a horizontal line to the scale at the left, which gives the losses directly in percentage of the heat in the coal. In this case the losses in the dry chimney gases are found to be 31.5 per cent of the heat in the coal.

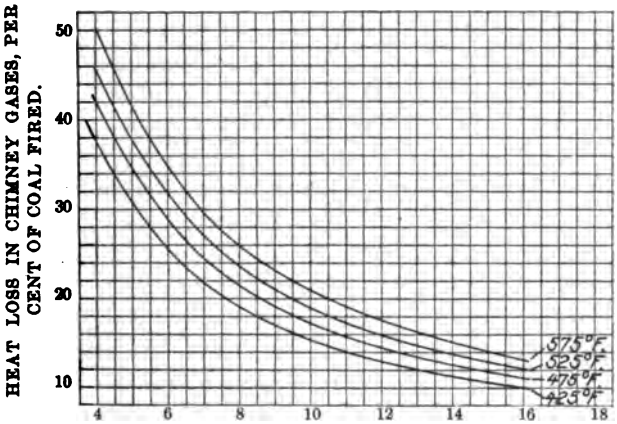


FIGURE 22.—Relation between the percentage of CO_2 in the flue gases and the heat lost in the dry chimney gases. Each of the curves gives this loss for one temperature difference between the flue gases and the air entering the furnace as indicated by the figures at the right of each curve.

EXAMPLE B.

CO_2 in flue gases =14.0 per cent.
Temperature of flue gases =650° F.
Temperature of boiler-room air=75° F.

The temperature difference between the flue gases and the boiler-room air is 575° F. Therefore the top curve should be used for this example.

Follow the vertical line of 14 per cent of CO_2 to the highest curve and from the intersection point a horizontal line to the scale at the left. The heat loss in the dry chimney gases is found to be 15 per cent.

The general characteristic of the curves is that as the CO_2 in the flue gases increases, the heat loss in the dry chimney gases decreases, at first very rapidly, but this decrease becomes small in the region of a high percentage of CO_2. For ordinary boiler furnaces probably it does not pay to run the CO_2 higher than 10 or 12 per cent. In many cases the leakage in the setting is such that the attainment of even 10 per cent is impossible.

CAUSES OF LOW CO_2 CONTENT.

The two principal causes of a low percentage of CO_2 are holes in the fire and leaky settings.

HOLES IN FIRES.

Technical Paper 80[a] describes the condition under which holes are formed in the fires, and points out the precautions that the fireman should use to prevent their formation. It suffices to repeat here that by firing small charges at short intervals of three to six minutes and by placing the fresh coal on the thin spots the formation of holes in the fuel bed can be prevented. It is not necessary to keep the fuel bed thicker than 5 or 6 inches. In fact, a 5-inch fuel bed if kept level may give higher percentages of CO_2 than a fuel bed 12 inches thick. The fireman is especially warned against heaping the coal on the front part of the grate and leaving the rear part uncovered.

LEAKY SETTINGS.

In the majority of instances leaky settings are the cause of a low percentage of CO_2 in the flue gases. This cause is harder to remove than the holes in the fires. Even a well-cared-for boiler setting allows a considerable volume of air to leak in. In the average plant probably not less than 30 per cent of the gases passing through the uptake leaks in through the setting. This feature is forcibly brought out by the gas analyses given in Tables 1 and 2 (pp. 51 and 52).

Table 1 gives the composition of the products of combustion as they pass through the uptake. Table 2 gives their composition as they enter a Heine boiler. The setting was seemingly in good condition; all the cracks as well as the joints between metal and brick wall were carefully packed with asbestos rope and the walls were painted with thick asphalt paint. In spite of all these precautionary measures considerable air entered the setting, as a comparison of the average values of the two tables shows. No serious objection can be made against the method of sampling the gases. Both sets of samples were collected simultaneously.

Similar difficulties are discussed in Bulletin 23.[b] All these data would seem to indicate that in plants where little attention is given to boiler settings the air leakage must be large indeed, and that it is important to keep boiler settings free from leaks as far as practicable if large chimney-gas losses are to be avoided.

In individual instances such losses can be approximately ascertained by taking simultaneous samples near the furnace, before the gases are diluted with the leakage, and in the uptake. It is advisable

[a] Kreisinger, Henry, Hand firing soft coal under power-plant boilers: Tech. Paper 80, Bureau of Mines, 1915, 83 pp.

[b] Breckinridge, L. P., Kreisinger, Henry, and Ray, W. T., Steaming tests of coal and related investigations, Sept. 1, 1904, to Dec. 31, 1908: Bull. 23, Bureau of Mines, 1912, pp. 289-293.

to take several sets of samples, the sampling tube being placed each time at a different point of the same cross section of the gas path. In estimating the leakage all sets of samples should be given consideration.

USE OF WATER-COOLED SAMPLER.

For the collection of a gas sample near the furnace it may be necessary to use a water-cooled sampler similar to the one shown in figure 23. Additional details of construction are shown in figure 27. Whenever possible this sampler should be used in a horizontal position. When used in this manner the trouble of the sampler becoming stopped with water condensation, soot, and tar will be greatly reduced.

The water inlet of this sampler must be connected to a cold-water supply of about 25-pounds pressure with a ½-inch garden hose, and

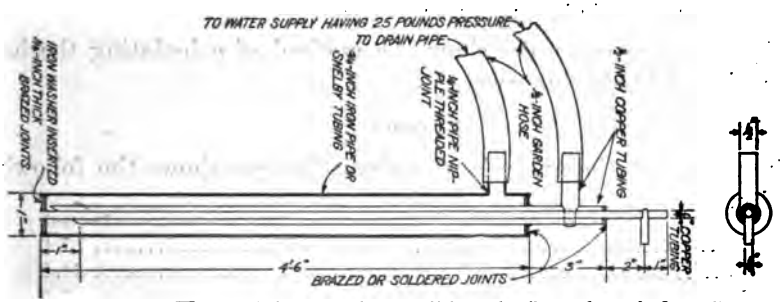


FIGURE 23.—Water-cooled gas sampler. Additional details are shown in figure 27.

the discharge from the sampler should be similarly connected to a drain. Both hose connections should be long enough to permit the sampler being inserted into or withdrawn from the furnace while the water is flowing through.

LOSSES FROM INCOMPLETE COMBUSTION.

In figure 21 the fourth side stream represents the total losses from incomplete combustion. By analyzing the flue gases for CO_2, O_2, and CO, the incomplete-combustion losses due to carbon burning to CO instead of to CO_2 can be determined. Such losses constitute perhaps one-half of the total incomplete-combustion losses. When 1 pound of carbon burns to CO_2, the combustion generates 14,500 British thermal units; when it burns to CO, only 4,500 heat units are generated. Thus 10,000 heat units are lost for every pound of carbon burning to CO. The gas analysis and the percentage of carbon in the coal furnish data for the computation of how much of the carbon in the coal fired burns to CO. With this quantity determined the heat loss due to this part of incomplete combustion can be obtained by multiplying by 10,000, which in round numbers is the heat value of 1 pound of carbon in the form of CO.

CALCULATION OF LOSSES DUE TO THE ESCAPE OF CO IN FLUE GASES.

The following are general formulas for the calculation of losses due to CO in flue gases:

(4) $$W=\frac{CO}{CO \text{ and } CO_2}\times\frac{C}{100}$$

where W=weight of carbon in pounds burned to CO for each pound of coal fired.
CO=percentage of CO in flue gases.
CO_2=percentage of CO_2 in flue gases.
C=percentage of carbon in coal.

(5) $$H=W\times 10{,}200$$

where H=heat loss in B. t. u. per pound of coal.
10,200=heat value in B. t. u. of 1 pound of carbon in the form of CO when burned to CO_2.

(6) $$L=\frac{H}{Q}$$

where L=the heat loss due to carbon burning to CO, expressed in percentage of heat in coal.
Q=heat value in B. t. u. per pound of coal.

The following examples show the method of calculating the heat losses due to CO in flue gases.

Example A.

Suppose that the analysis of a given flue gas shows the following results:

	Per cent.
CO_2	7.0
O_2	11.2
CO	0.8

Suppose the carbon content of the coal burned to be 82 per cent. The heat value of 1 pound of the coal is 13,500 B. t. u.

Substitution of the values given by the analysis in equation 4 gives:

$W=\frac{0.8}{0.8+7.0}\times\frac{82}{100}=0.084$ pound of carbon burned to CO for each pound of coal fired.

$H=0.084\times 10{,}200=857$ B. t. u. lost per pound of coal burned.

$L=\frac{857\times 100}{13{,}500}=6.3$ per cent of the heat in coal fired is lost in CO.

Example B.

Suppose that the analysis of a given flue gas gives the following results:

	Per cent.
CO_2	12.0
O_2	5.6
CO	1.4

Suppose the carbon content of the coal burned to be 82 per cent. The heat value of 1 pound of the coal is 13,500 B. t. u.

Substitution of the values given by the analysis in equation 4 gives:

$W=\frac{1.4}{1.4+12.0}\times\frac{82}{100}=0.085$ pounds of carbon burned to CO for each pound of coal fired.

$H=0.085\times 10200=867$ B. t. u. lost per pound of coal.

$L=\frac{867\times 100}{13,500}=6.4$ per cent of the heat in coal fired lost in CO.

The two specific examples show that the heat loss due to carbon burning to CO instead of CO_2 depends not only on the percentage of CO in flue gases but also on the CO_2 content. This fact is shown more clearly in figure 24 which shows the relation between the percentage of CO in the flue gases and the heat losses due to the escape of CO. Each of the curves gives this loss for one constant percentage of CO_2, as indicated by the figures under the curves. The curves are compiled for coal containing 82 per cent of carbon and having a heat value of 13,500 B. t. u. It is apparent from the position of these curves that the higher the percentage of CO_2 the lower is the heat loss for the same percentage of CO. Thus, with 1 per cent of CO and

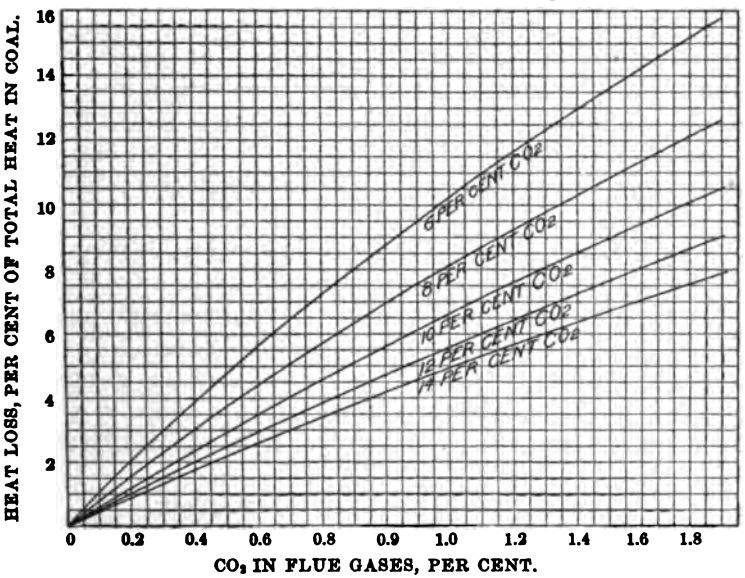


FIGURE 24.—Relation between the percentage of CO in the flue gases and the heat losses due to the escape of CO. Each curve gives the loss for one constant percentage of CO_2 as indicated under each curve.

6 per cent of CO_2, the loss is 8.8 per cent of the total heat in the coal, whereas if the percentage of CO_2 in the gases is 14, 1 per cent of CO causes only 4.2 per cent heat loss.

The curves of figure 24 can be used for computing approximately the incomplete combustion losses due to CO in flue gases. Thus, example A, on page 42, can be worked out as follows:

The vertical line starting from the point of 0.8 per cent at the bottom of the chart is followed to a point somewhat less than halfway between the curves of 8 and 6 per cent of CO_2. From this point a horizontal line is followed to the scale at the left which gives the heat losses for this example to be about 6.3 per cent, or the same as computed by the arithmetic.

Example B is worked out by means of the chart as follows:

From the point of 1.4 per cent of CO at the bottom of the chart follow the vertical line to the curve of 12 per cent of CO_2. From the intersection point of this curve follow the horizontal line to the scale at the left, which gives the losses to be about 6.4 per cent, or about the same as computed in the example.

Attention is called to the fact that CO constitutes only a part of the incomplete combustion losses. In burning soft coal when CO appears there are usually some hydrogen and gaseous hydrocarbons as well as tar vapors and soot escaping through the chimney along with CO. The tar vapors and soot form a large part of the visible smoke. Therefore the appearance of CO must be considered as only one indication of incomplete combustion. The total incomplete combustion may be twice as much or even more than that shown by the percentage of CO in the flue gases. In most plants the incomplete combustion losses are small compared to the heat carried away by the chimney gases; however, in some instances, these losses are great.

In the hand-fired furnaces CO appears in appreciable quantities one or two minutes after firing, as is shown in Table 5 (p. 57). Additional air supplied through the firing door immediately after firing tends to reduce the percentage of CO in the flue gases.

The determination of hydrogen and hydrocarbons requires more complicated apparatus than the Orsat and necessitates great skill on the part of the operator. Therefore it is not discussed in this report.

CAUSES OF INCOMPLETE COMBUSTION.

The chief causes of incomplete combustion are an insufficient supply of air admitted above the fuel bed and lack of proper mixing of this air with the combustible rising from the fuel bed. Perhaps in ordinary boiler furnaces the lack of proper mixing is more often the cause of incomplete combustion than the insufficient supply of air.

The amount of air introduced into the furnace, both through the grate and the firing door, can be approximately determined by the analysis of a gas sample taken in the furnace, or in some other place within the setting before the gases are diluted by the air leakage through the setting. Such samples should be collected with a water-cooled sampler similar to that shown in figure 23.

Several samples must be collected and analyzed, and the conditions of fire under which the samples are collected must be carefully observed and considered before the true condition of the combustion can be ascertained. Air leaking into the setting beyond the furnace seldom helps the combustion if combustible material is contained in the gases, because the temperature is usually too low for the ignition

and burning of the combustible material. Therefore the analysis of a gas sample collected in the uptake may show both incomplete combustion and a large excess of air. In the average plant, if reasonable care is taken of the boiler setting, 10 to 12 per cent of CO_2 in the flue gases gives about the best results as regards excess of air and incompleteness of combustion.

In some plants the CO_2 may reach as high as 14 per cent with only traces of incomplete combustion, whereas in other plants even 8 per cent of CO_2 may be accompanied with a considerable loss from incomplete combustion.

DESIRABILITY OF ANALYZING FLUE GASES.

The question may be asked, Is it desirable in all steam plants to analyze flue gases? In general, it can be said that it is desirable. Whether the gases should be sampled and analyzed continuously or periodically depends perhaps on the size of the plant and the nature of the load. In some of the large plants generating power 24 hours a day gases are sampled and analyzed continuously, and the fireman is paid a bonus according to how good a combustion he is able to obtain, the quality of the combustion being determined by analysis of the flue gases. The gas samples are analyzed either with an Orsat apparatus or with an automatic CO_2 recorder. This plan should be tried wherever it appears at all feasible.

In some plants, particularly those of smaller capacity and those operating with full load only during the day hours, it may perhaps not be practicable to sample and analyze gases continuously. In such plants gas sampling and analyzing should be applied long enough to determine definitely the prevailing furnace conditions and the efficiency of the methods of firing. When such determination has been made the proper remedies to increase the efficiency of the steam plant can be applied. In hand-fired plants such remedies consist chiefly of getting the fireman into the habit of firing small charges at short intervals and keeping the fuel bed free from holes by placing the fresh coal on the thin spots. Small and frequent firing makes the amount of combustible rising from the fuel bed nearly uniform and proportional to the constant air supply, so that incomplete combustion is thus reduced to a minimum. By keeping the fuel bed free from holes a large excess of air in the furnace is avoided. Stopping air leakages into the setting further helps in reducing the excess of air. After the efficient firing has been well established and the boiler settings put into good condition, the analyzing of the gases may be stopped and used only at intervals to check the fireman and to find whether the settings remain in good condition.

EXPERIMENTAL RESULTS OF SAMPLING AND COLLECTING FLUE GASES.

The recommendation of the methods of sampling and collecting flue gases already described are based on experimental data. Some of these data have been accumulated during investigations of the combustion of coal; other data have been obtained from experiments made especially for the purpose of obtaining information on the subject of sampling and collecting flue or furnace gases. Inasmuch as these data show plainly what accuracy can be expected when

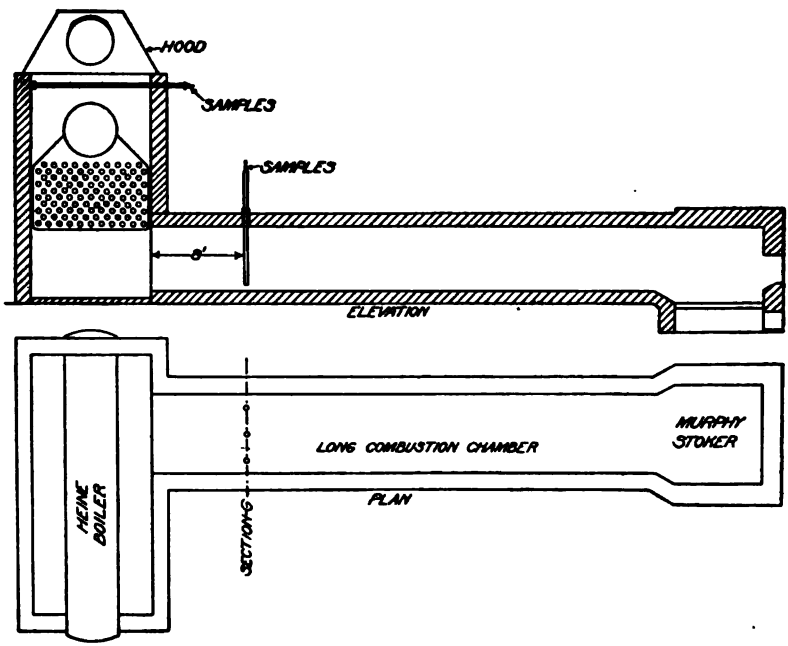


FIGURE 25.—Outline of experimental furnace with long combustion chamber connected to a Heine boiler. Section G in long combustion chamber is 8 feet from the entrance of gases into the Heine boiler.

flue gases are being sampled with various devices, the data are here presented and discussed.

The experiments, according to what they are intended to illustrate, are grouped into three classes, as follows:

(*a*) Experiments with different devices for sampling gases in water-tube and fire-tube boilers.

(*b*) Experiments showing the difficulty of collecting gases at a uniform rate over periods of three to five hours.

(*c*) Experiments on the absorption of CO_2 by water and brine used in collecting bottles.

EXPERIMENTS ON SAMPLING FLUE GASES.

Three series of tests were made to determine when the open-end single-tube sampler can be relied on to collect approximately the average sample, and when it is advisable to use the perforated tube sampler or some other more complex device. The first series of tests was made on a Heine boiler into which were discharged the hot products of combustion from a special experimental furnace. This furnace consisted essentially of a Murphy stoker, with a grate area of 25 square feet, and a combustion chamber 3 by 3 feet in cross section and about 45 feet long. The end of the combustion chamber was connected to the side of the boiler. The outline of the combined apparatus is shown in figure 25.

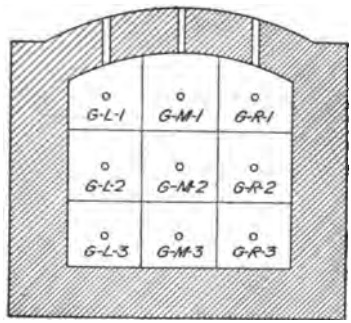


FIGURE 26.—Placing of samplers at section G of the long combustion chamber.

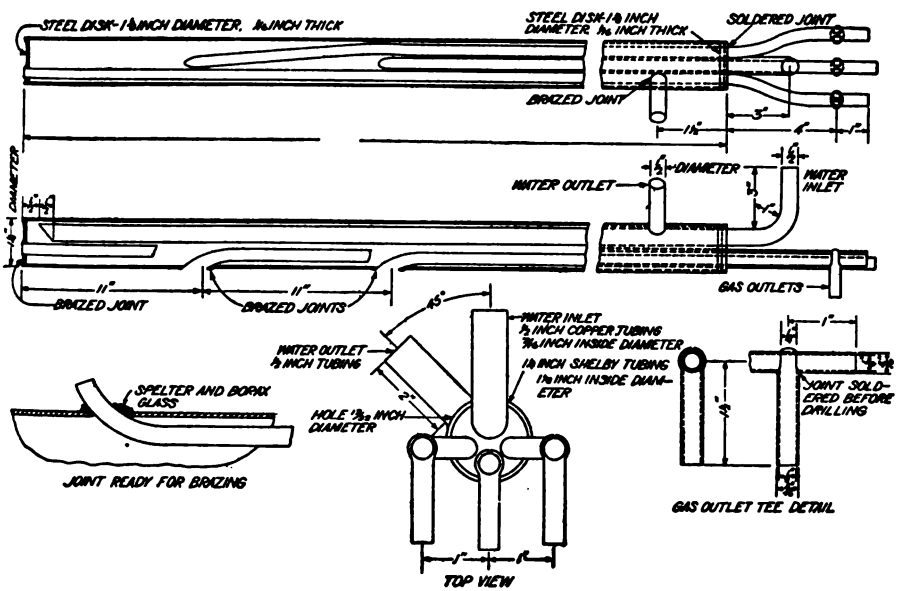
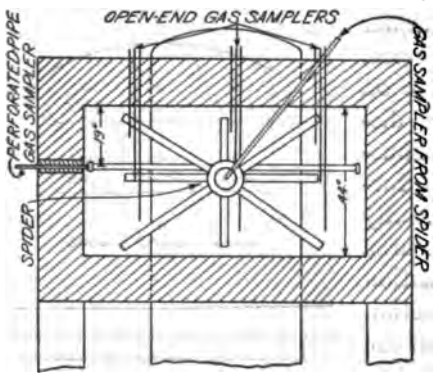


FIGURE 27.—Water-cooled gas sampler having three gas tubes in one water jacket. All joints that come in contact with flames are brazed; joints that remain outside of the furnace are soldered. When the sampler is being brazed or soldered, it should be held in such a position that the molten spelter or solder runs into the joint; this is important if good joints are to be obtained. When the joints to be brazed are being fitted, care should be taken to have the end of the copper tubing extend out far enough so that the spelter will not run down into it. After the joint has been brazed, the protruding end of the copper tube can be filed off. The side outlets on the gas tubes are first fitted as shown and then soldered by placing a piece of solder into the side outlet and heating the joints over a gas-torch flame, the side outlet being held up so that the molten solder runs all around the joint. The hole between the side outlet and the gas tube is drilled after the joint has been soldered. The gas sample is drawn through the side outlet, and the opening at the end of the gas tube is closed with a piece of rubber tubing and a glass plug and is used only when the tube is being cleaned after it has become stopped with soot.

The products of combustion were sampled at section G just before they entered the boiler and again in its uptake, where three different sampling devices were installed. At section G nine open-end sampling tubes were placed as shown in figure 26, so that each tube sampled gases from approximately 1 square foot of cross-sectional area.



The sampling tubes were inserted through the holes in the arch. The samplers were water cooled, three tubes being inclosed in one water jacket as shown in figure 27. Through each of the sampling tubes the gas was collected into a separate gas holder.

In the uptake were placed nine open-end sampling tubes, one perforated sampler, and a special sampling device, which, on account of its shape, was called a "spider." The placing of these devices is shown in figures 28, 29, and 30.

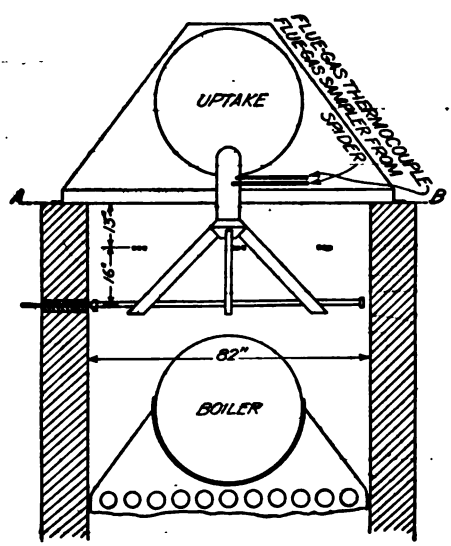


FIGURE 28.—General arrangement of three kinds of sampling devices in the uptake of a Heine boiler connected to long combustion chamber.

The open-end tubes consisted of standard ¼-inch pipe. They were inserted into the uptake through three holes in the rear wall.

The perforated-tube sampler was of the same design as that shown in figure 5. It consisted of a piece of 1¼-inch pipe 7 feet long, closed at both ends. The small tube extending to its center was standard ¼-inch pipe. The perforations were one-sixteenth of an inch in diameter and 3 inches apart. This sampler was inserted into the uptake through a hole in the side wall.

The "spider" was a device for obtaining the average sample and the average temperature of flue gases. It was made of No. 20 galvanized sheet iron. The details of its construction are shown in figure 31.

The gas entered the device through the long narrow opening in the bottom of the "legs." The streams of gas from the eight legs came together in the conical body and left through the 6-inch pipe bent into the breeching. A ¼-inch pipe was inserted into the center of the 6-inch pipe for drawing the sample. Immediately above this ¼-inch pipe was placed the junction of a thermocouple for measuring the temperature of the flue gases.

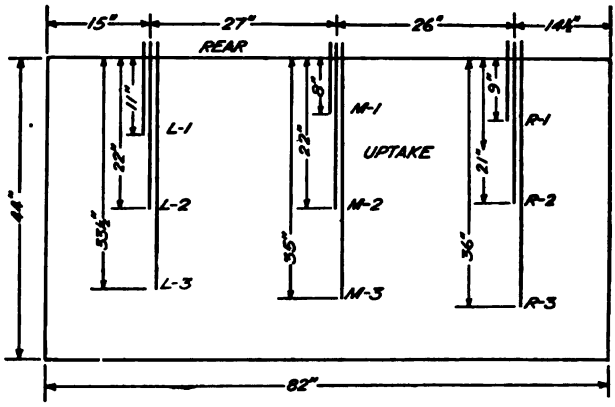


FIGURE 29.—Placing of nine open-end samplers in uptake of Heine boiler.

Each of the nine open-end sampling tubes, the perforated sampler, and the ¼-inch pipe taking gas out of the "spider" were connected to separate gas-collecting devices, one of which is shown in figure 32.

The collecting devices were connected with a 1¼-inch pipe to a strong steam ejector which caused a continuous stream of gas to flow through each of the sampling tubes. The gas streams were caused to bubble through the water in the wash bottle, so that if any of the sampling tubes became clogged the bubbling in the wash bottle ceased. Thus no sample could be missed without the operator knowing it. The gas was collected over mercury in glass holders of 125 c. c. capacity. The design of the gas holder is given in Plate I, which shows a table and equipment for collecting nine samples.

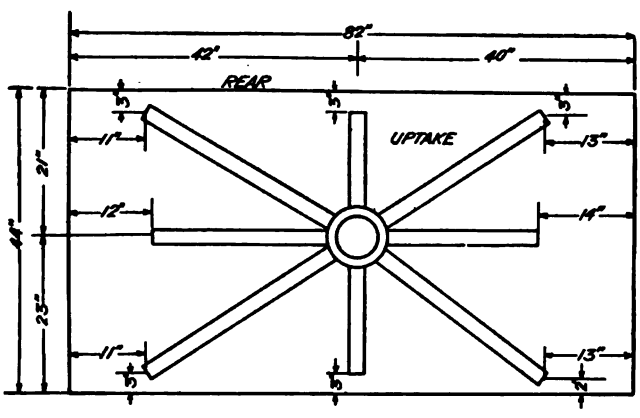


FIGURE 30.—Placing of the "spider" in uptake of Heine boiler.

The gas holders are mounted in wooden stands, each of which contains three gas holders. The figure shows one of the stands removed,

so that the wash bottles and their connections may be seen more clearly.

All samples were collected simultaneously and the time of collecting them was about 20 minutes.

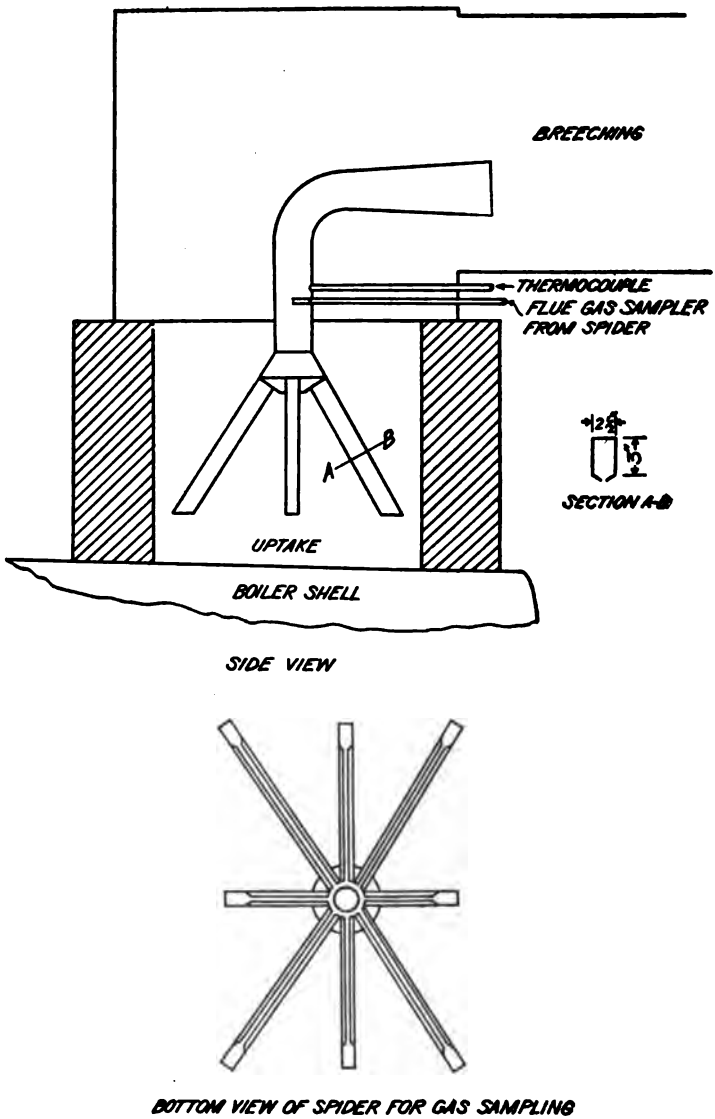


FIGURE 31.—Details of construction of "spider." Bottom view shows openings through which gases enter "spider." Side view shows placing of "spider" with respect to hood and breeching.

Tables 1 and 2 following show the composition of eight sets of simultaneous samples collected from the Heine boiler connected to the experimental long combustion chamber.

EQUIPMENT FOR COLLECTING NINE SAMPLES OF FLUE GASES.

The nine samples can be identified by reference to figure 29. The test number refers to the test with the experimental furnace.

TABLE 1.—*Results of analyses of samples taken in the uptake of a Heine boiler.*

Sample.[a]	Test 185.		Test 186.		Test 187.		Test 188.	
	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2
L-1	5.8	14.2	7.9	11.7	8.9	10.4	8.7	10.8
L-2	5.9	13.9	7.9	11.8	8.9	10.3	9.1	10.2
L-3	5.5	14.5	8.3	11.4	9.3	9.7	9.8	9.6
M-1	5.7	14.3	7.6	12.0	8.8	10.7	8.7	10.7
M-2	5.7	14.4	7.9	11.7	8.7	10.5	8.8	10.6
M-3	5.5	14.5	8.1	8.2	9.1	9.9	8.8	10.4
R-1	6.7	13.0	9.8	9.5	9.8	9.6	9.7	8.9
R-2	6.0	14.0	8.7	10.8	10.1	9.0	9.9	9.4
R-3	5.0	15.0	7.4	12.3	8.3	11.3	8.3	11.3
Average	5.75	14.2	8.2	11.0	9.1	10.2	9.1	10.2
Maximum variation	5.0 to 6.7	.....	7.4 to 9.8	.....	8.3 to 10.1	.....	8.3 to 9.9	.....
(b)	5.6	14.6	8.1	11.4	8.9	10.3	8.8	10.5
(c)	5.5	14.1	8.4	11.2	9.2	10.0	9.4	10.0

Sample.[a]	Test 189.		Test 190.		Test 192.		Test 193.	
	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2
L-1	9.0	10.7	8.4	11.0	11.0	8.0	11.3	6.8
L-2	10.1	9.4	9.2	10.2	10.6	8.7	9.7	9.3
L-3	10.9	8.1	10.6	8.6	9.7	9.8	10.1	8.8
M-1	8.8	9.1	9.0	10.3	9.3	9.6	9.9	9.0
M-2	9.9	9.7	9.3	9.8	9.9	9.2	10.7	8.2
M-3	9.4	9.9	9.2	10.1	9.8	9.8	10.5	8.5
R-1	11.1	7.2	10.5	8.8	9.2	10.4	9.5	9.1
R-2	11.1	7.9	10.2	8.8	10.3	9.7	11.0	7.8
R-3	9.1	10.5	8.2	11.3	11.5	8.8	11.9	6.7
Average	9.9	9.2	9.4	9.9	10.1	9.3	10.5	8.2
Maximum variation	8.8 to 11.1	.....	8.2 to 10.6	.....	9.2 to 11.5	.....	9.5 to 11.9	.....
(b)	.....	.....	9.1	10.2	9.5	9.5	10.5	8.3
(c)	10.1	9.4	9.5	9.9	.....	.....	.....	.....

[a] See figure 29, p. 49. [b] Sample taken with "spider." [c] Sample taken through 1¼-inch perforated pipe.

TABLE 2.—*Results of analyses of samples collected at section G of long combustion chamber.*

Sample.[a]	Test 185.			Test 186.			Test 187.			Test 188.		
	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO
G-L-1	8.5	10.8	0.0	12.8	5.9	0.0	14.2	4.4	0.0	14.8	3.5	0.3
L-2	8.8	10.8	.0	12.9	6.2	.0	14.1	4.4	.0	15.0	3.5	.2
L-3	9.0	10.5	.0	13.3	5.6	.0	14.7	3.8	.0	14.9	3.6	.3
G-M-1	9.2	10.4	.0	13.0	5.6	.1	14.4	3.9	.0	14.8	3.6	.3
M-2	9.3	10.3	.0	13.1	5.6	.0	14.0	4.4	.0	14.1	4.3	.2
M-3	9.3	10.2	.1	13.2	5.7	.1	13.1	5.3	.0	14.9	3.6	.3
R-1	5.6	14.5	.0	11.5	7.5	.0	13.7	5.1	.0	13.1	5.4	.1
R-2	9.8	9.7	.0	13.2	5.7	.0	14.3	4.2	.0	15.0	3.4	.3
R-3	10.0	9.5	.0	13.4	5.6	.0	13.4	5.5	.0	14.8	3.5	.4
Average	8.8	10.7	.0	12.9	5.9	.0	14.0	4.6	.0	14.6	3.8	.3
Maximum variation	5.6 to 10.0	.....	.....	11.5 to 13.4	.....	.....	13.1 to 14.7	.....	.....	13.1 to 15.0	.....	.....

[a] See figure 26, p. 47.

TABLE 2.—*Results of analyses of samples collected at section G of long combustion chamber*—Continued.

Sample.[a]	Test 189.			Test 190.			Test 192.			Test 193.		
	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO
G–L–1	14.6	4.1	0.0	14.3	4.3	0.0	13.5	4.9	0.0	13.7	4.7	0.0
L–2	14.6	3.8	.0	14.0	4.1	.0	13.9	4.3	.2	13.5	4.9	.0
L–3	14.6	4.0	.0	14.0	4.5	.0	13.3	5.3	.1	13.5	5.0	.1
G–M–1	14.7	3.6	.0	14.2	4.2	.0	14.3	3.9	.0	14.2	3.7	.0
M–2	[b].6	[b]20.2	.0	12.3	5.5	.0	15.2	2.4	.0	14.6	3.8	.0
M–3	14.7	4.0	.0	13.8	4.9	.0	11.3	7.2	.3	12.5	5.9	.0
R–1	12.5	6.5	.0	12.5	6.1	.0	11.1	7.8	.0	14.7	3.6	.1
R–2	14.8	3.5	.0	14.3	4.2	.0	14.9	3.4	.1	14.6	3.6	.0
R–3	15.0	3.4	.0	14.0	4.4	.0	15.1	3.3	.1	15.0	3.4	.0
Average	14.4	4.1	.0	13.7	4.7	.0	13.6	4.7	.1	14.0	4.3	.0
Maximum variation	12.5 to 15.0	.....	.0	12.3 to 14.3	.....	.....	11.1 to 15.2	.....	.....	12.5 to 15.0	.....	.....

[a] See figure 26, p. 47. [b] Not included in average; leakage in tube.

Table 1 shows that with the boiler equipment used the center sample, designated M–2, came as near to the average as the "spider" sample or the sample taken through the perforated tube. Therefore, with similar installations it would be safe to use the open-end tube placed in the center of the cross sections of the uptake.

As shown by the analysis of the samples collected at section G (Table 2), the gas is of a fairly uniform composition when it enters the boiler. The uniformity is undoubtedly the result of the long travel of the gas through the unusually long combustion space of the experimental furnace which gives the gases an opportunity to mix. If the gases enter the boiler uniformly mixed, it is to be expected that they leave it in a similarly uniform composition. It is only the air leakage into the boiler setting that could possibly destroy such uniformity of composition. Comparison of the analyses of gases collected in the uptake with those of the gases collected at section G will indicate that a considerable amount of air leaked into the setting. However, the mixing of the gases as they pass among the boiler tubes is such that the gases come out nearly uniformly diluted with air over the entire cross section of the uptake.

To determine whether the mixing of the gases as they pass through the boiler is sufficient to cause a uniform gas mixture in the uptake, a set of nine open-end sampling tubes and one perforated tube was placed in the uptake of a Heine boiler equipped with a Jones underfeed stoker. The stoker was placed directly under the boiler as in the standard commercial installation. The gases passed first under the boiler to the rear, then among the boiler tubes to the front, and then under the steam drum to the uptake in the rear of the boiler. The placing of the sampling tubes is shown in figure 33. The tubes were connected to the same gas-collecting apparatus as shown in figure 32 and Plate I.

Four sets of samples were collected in this installation. The time of collecting the samples was about 15 minutes. The analyses of the samples are given in Table 3. The table shows that the mixing of the gases as they pass among the boiler tubes is such that the

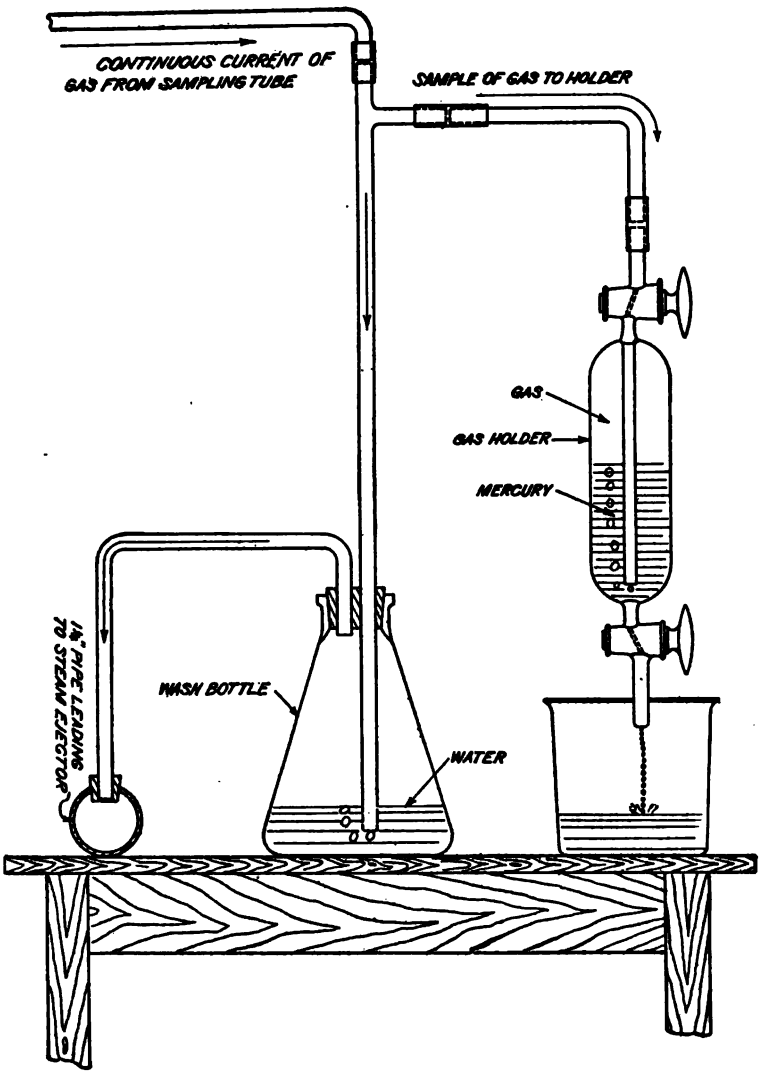


FIGURE 32.—Gas-collecting device in which gas is collected over mercury.

gas mixture in the uptake is fairly homogeneous. The composition of the sample collected with the central open-end tube was nearly the same as that of the sample collected with the perforated sampling tube, and both were close to the average of the nine samples.

TABLE 3.—*Results of analyses of samples taken in uptake of a Heine boiler equipped with Jones underfeed stoker.*

Sample.[a]	Set 1.				Set 2.			
	CO_2.	O_2.	CO.	CO_2 $+O_2$ $+\frac{1}{2}CO$.	CO_2.	O_2.	CO.	CO_2 $+O_2$ $+\frac{1}{2}CO$.
L-1	6.0	13.6	0.0	19.6	9.2	10.1	0.1	19.3
L-2	5.0	14.8	0.0	19.8	7.9	11.4	0.0	19.3
L-3	4.9	14.4	0.0	19.3	8.0	11.5	0.0	19.5
M-1	6.0	12.0	0.1	18.0	9.1	10.0	0.1	19.1
M-2	5.8	13.4	0.0	19.2	9.1	10.3	0.1	19.4
M-3	5.7	14.2	0.1	19.9	9.1	7.4	0.0	16.5
R-1	6.2	13.6	0.1	19.8	10.4	8.9	0.1	19.3
R-2	5.9	14.0	0.0	19.9	9.3	10.2	0.1	19.5
R-3	5.7	14.2	0.1	19.9	9.0	10.6	0.1	19.6
Average	5.7	13.8	0.0	19.5	9.1	10.1	0.1	19.2
Maximum variation	4.9 to 6.2	.....	.....	.....	7.9 to 10.3	.....	.....	.....
(b)	5.9	14.0	0.1	19.9	9.1	10.3	0.1	19.4

Sample.[a]	Set 3.				Set 4.			
	CO_2.	O_2.	CO.	CO_2 $+O_2$ $+\frac{1}{2}CO$.	CO_2.	O_2.	CO.	CO_2 $+O_2$ $+\frac{1}{2}CO$.
L-1	10.5	8.8	0.3	19.4	11.8	7.2	0.2	19.1
L-2	8.6	10.6	0.4	19.4	10.8	8.3	0.1	19.1
L-3	9.3	10.0	0.1	19.3	11.1	8.0	0.1	19.1
M-1	10.8	8.3	0.0	19.1	11.0	6.3	0.0	17.3
M-2	10.2	9.0	0.0	19.2	11.8	7.2	0.2	19.1
M-3	10.2	6.8	0.0	17.0	12.0	5.4	0.0	17.4
R-1	11.0	7.9	0.1	18.9	12.6	6.2	0.0	18.8
R-2	10.4	8.9	0.0	19.3	11.9	7.0	0.1	18.9
R-3	10.0	9.2	0.1	19.2	11.8	7.1	0.1	18.9
Average	10.1	8.8	0.1	18.9	11.6	7.0	0.1	18.6
Maximum variation	8.6 to 11.0	.....	.....	.....	10.8 to 12.6	.....	.....	.....
(b)	10.3	9.1	0.1	19.4	11.8	7.4	0.2	19.3

[a] See figure 33. [b] Sample taken through 1½-inch perforated pipe.

The preceding analyses of gas samples show that the gases in the uptake of a water-tube boiler form a fairly homogeneous mixture. This uniformity of mixture is ascribed to the fact that the gases mix freely as they pass among the tubes. In any fire-tube boiler no such mixing can occur; the gases in each tube stay separate as long as they stay in the tubes. Therefore, it would seem that the gases in the uptake of a horizontal tubular boiler would not be a uniform mixture, but that their composition would vary considerably in different parts of the uptake. To determine how much this variation is, a set of nine open-end sampling tubes was placed in the uptake of a 100-horsepower horizontal tubular boiler and several sets of simultaneous samples were collected and analyzed. The placing of the sampling tubes in the uptake is shown in figure 34.

The tubes were connected to the gas-collecting apparatus shown in figure 32. The sample from each tube was collected over mercury in a separate gas holder. The time of collecting the gas sample was

about two minutes. Table 4 gives the analyses of the first four sets of samples. No sample was collected with a perforated-tube sampler. The analyses show that the composition varies over a wide range, and that the central sample as a rule contains a higher percentage of CO_2 than the average of the nine tubes.

Table 5 gives the analyses of four more sets of samples collected at various intervals after four equal and consecutive firings. Simultaneous samples were also collected with a perforated-tube sampler placed near the intakes of the nine open-end sampling tubes as shown in figure 34. The sample collected through the perforated sampler was nearer to the average than the sample taken with the center open-end tube; however, the difference was by no means small or negligible. The variation of the composition of the samples shows rather emphatically that it is very difficult, if not impossible, to collect a sample of flue gas that will represent the average composition of gases at a given cross section in the uptake of a horizontal return-tubular boiler.

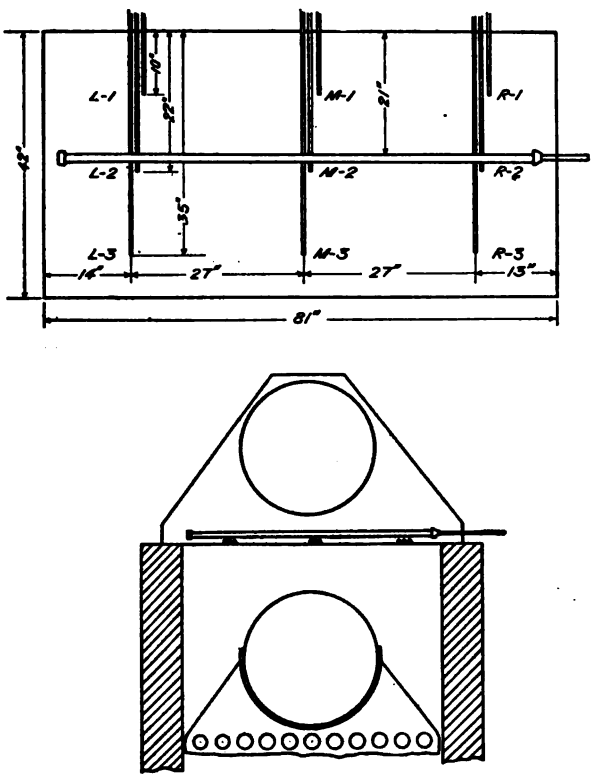


FIGURE 33.—Placing of nine open-end sampling tubes and a perforated-pipe sampler in a Heine boiler equipped with Jones stoker.

In general, it may be stated that flue or furnace gas samples as they are ordinarily taken do not represent the average composition of the entire stream of gas nearer than 0.5 per cent of CO_2, and in many instances the sample collected is 1 per cent or more of CO_2 higher or lower than the true average. It is therefore useless to make the analyses any closer than to the nearest 0.5 per cent of CO_2, particularly if no determination of the combustible gases is made.

TABLE 4.—*Results of analyses of samples collected in uptake of horizontal return-tubular boiler.*

Sample No.[a]	Set 1.			Set 2.				
	CO_2.	O_2.	CO_2+ O_2+ ½CO.	CO_2.	O_2.	CO.	H_2.	CO_2+ O_2+ ½CO.
1	10.1	8.6	18.7	12.1	7.3	.....	.....	19.4
2	12.4	6.5	18.9	14.8	4.0	.....	.....	18.8
3	12.2	6.8	19.0	15.3	3.3	.....	.....	18.6
4	12.9	5.3	18.2	16.0	2.6	0.8	0.0	19.0
5	13.2	5.8	19.0	15.0	3.4	1.0	0.2	18.9
6	9.0	10.3	19.3	13.4	5.4	0.5	0.4	19.0
7	8.6	10.7	19.3	11.8	7.4	.....	.....	19.2
8	8.3	11.2	19.5	12.7	6.5	.....	.....	19.2
9	9.0	10.3	19.3	13.4	4.4	.....	.....	17.8
Average	10.6	8.4	19.0	13.8	4.9	.....	.....	18.7
Maximum variation	8.3 to 13.2	.....	.....	11.8 to 16.0	.....	.....	.....	.....

Sample No.[a]	Set 3.						Set 4.			
	CO_2.	O_2.	CO.	H_2.	CH_4.	CO_2+ O_2+ ½CO.	CO_2.	O_2.	CO.	CO_2+ O_2+ ½CO.
1	9.0	7.3	5.5	2.3	0.4	19.1	12.8	7.2	0.1	20.0
2	10.7	4.9	6.6	3.1	.3	18.9	15.2	4.2	0.0	19.4
3	12.0	3.5	5.9	2.7	.4	18.5	15.7	4.6	0.0	20.3
4	12.5	2.7	5.9	2.6	.3	18.2	14.2	5.7	0.0	19.9
5	11.9	4.4	3.7	1.7	.1	18.2	12.7	7.0	0.0	19.7
6	10.3	7.2	2.8	1.3	.1	18.9	11.8	8.1	0.0	19.9
7	10.2	7.4	2.8	1.0	.3	19.0	10.7	9.8	0.0	20.5
8	10.1	7.4	2.7	.7	.4	18.9	10.8	9.2	0.0	20.0
9	11.5	6.2	1.9	.9	.3	18.7	10.2	9.3	0.1	19.5
Average	10.9	5.7	4.2	1.8	.3	18.7	12.7	7.2	.....	19.9
Maximum variation	9.0 to 12.5	.....	.....	.....	.....	.....	10.2 to 15.7	.....	.....	.....

[a] See figure 34.

TABLE 5.—*Results of analyses of samples collected in uptake of horizontal return-tubular boiler at various intervals after firing.*

Sample No.[a]	Immediately after firing.						1½ minutes after firing.					
	CO_2.	O_2.	CO.	CH_4.	H_2.	CO+CH_4+H_2.	CO_2.	O_2.	CO.	CH_4.	H_2.	CO+CH_4+H_2.
1[b]	0.0	20.0	.....	.....	.....	.....	8.3	10.1	1.1	0.0	0.5	1.6
2	9.8	7.4	2.5	0.5	1.1	4.1	10.2	7.7	1.5	.0	1.2	2.7
3	9.8	7.4	2.5	.5	1.2	4.2	11.9	5.5	1.7	.2	.4	2.3
4	10.4	6.4	2.8	.7	1.3	4.8	12.3	5.1	1.7	.2	.5	2.4
5	9.8	7.2	2.7	.7	1.4	4.8	11.2	6.2	2.0	.3	.7	3.0
6	10.0	6.8	2.9	.8	1.8	5.5	11.2	6.0	2.2	.3	.9	3.4
7	8.6	8.4	2.9	.5	.9	4.3	8.9	8.8	1.9	.3	.9	3.1
8	7.4	10.0	2.2	.2	1.7	4.1	8.7	9.2	2.0	.4	.6	3.0
9	7.1	9.3	2.4	.4	1.4	4.2	8.4	9.2	2.0	.5	.4	2.9
Average	9.1	7.9	2.6	.5	1.4	4.5	10.1	7.5	1.8	.2	.7	2.7
Maximum variation	7.1 to 10.4	.....	.....	.....	.....	.....	8.3 to 12.3	.....	.....	.....	.....	.....
(c)	9.5	7.5	2.3	.4	1.5	4.2	10.4	6.7	1.5	.1	.5	2.1

[a] See figure 34. [b] Air leak. [c] Sample taken through 1-inch perforated pipe.

TABLE 5.—*Results of analyses of samples collected in uptake of horizontal return-tubular boiler at various intervals after firing*—Continued.

Sample.[a]	2½ minutes after firing.						3½ minutes after firing.					
	CO_2.	O_2.	CO.	CH_4.	H_2.	$CO+CH_4+H_2$.	CO_2.	O_2.	CO.	CH_4.	H_2.	$CO+CH_4+H_2$.
1[b]	9.2	9.6	0.4	0.0	0.0	0.4	9.5	8.6	0.8	0.0	0.2	1.0
2	11.7	6.5	.5	.0	.0	.5	11.2	6.4	.9	.0	.4	1.3
3	12.4	5.7	.2	.0	.0	.2	12.5	5.1	.9	.0	.4	1.3
4	12.8	5.5	.2	.0	.0	.2	12.4	4.6	1.5	.....	.....	.....
5	11.7	5.9	.7	.0	.1	.8	11.7	5.8	1.0	.0	.1	1.1
6	11.0	6.4	.7	.0	.4	1.1	11.5	6.3	.8	.0	.1	.9
7	9.7	7.1	1.6	.1	.6	2.3	10.7	7.5	.4	.0	.1	.5
8	9.0	9.5	.6	.0	.2	.8	8.4	10.3	.2	.0	.1	.3
9	9.8	7.8	1.1	.0	.0	1.1	8.9	9.7	.3	.0	.1	.4
Average	10.8	7.1	.7	.....	.1	.8	10.8	7.1	.8	.0	.2	1.0
Maximum variation	9.0 to 12.8	.....	.....	.....	.....	.....	8.4 to 12.5	.....	.....	.....	.....	.....
(c)	11.4	6.8	.2	.0	.1	.3	12.3	5.3	.9	.0	.4	1.3

[a] See figure 34. [b] Air leak. [c] Sample taken through 1-inch perforated pipe.

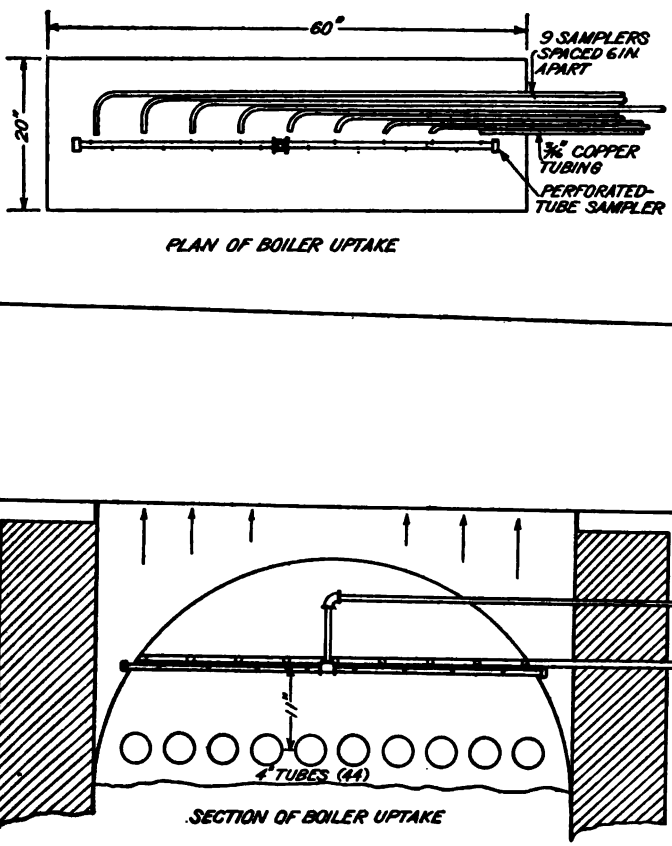


FIGURE 34.—Placing of nine open-end sampling tubes and a perforated pipe sampler in a horizontal return tubular boiler. The open-end tubes are of 3/16-inch copper tubing.

EXPERIMENTS ON COLLECTING GASES.

In sampling flue gases it is desirable to collect the sample at a uniform rate for a period ranging from 15 minutes to several hours. The longer this period the more difficult it is to obtain a uniform rate of collecting gases with the ordinary 2-gallon collecting bottles. The main difficulty in collecting gas over long periods is that the water must be run out of the bottle through a very small opening which is apt to become stopped with small particles of dirt floating in the water. When the small opening is made by pinching the rubber tubing by the screw clamp shown in figure 9, the opening has a shape of a long and narrow slit which acts as a filter and catches all the dirt and becomes stopped. Better results can be obtained by using a small orifice like that shown in figure 35.

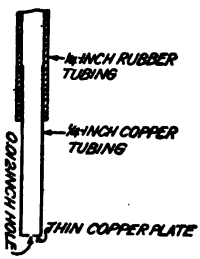


FIGURE 35.—Orifice used to obtain a uniform flow of water. The copper tube is inserted into the rubber tubing which discharges water into lower collecting bottle.

The orifice has a round opening which does not clog as easily as the long narrow slit formed by compressing the rubber tubing with the screw clamp. When collecting gas samples over long periods it is important that the water or brine used be free from all dirt. Filtering the brine or water through filter or blotter paper reduces the trouble from clogging.

Numerous experiments were made in the gas laboratory of the Bureau of Mines to determine how uniform a rate of collecting the gas may be expected when the sampling is extended over periods of 1 to 5 hours. Some of the results obtained are plotted in figure 36.

The horizontal distance of the chart gives the time over which the gas was collected. The vertical distance of the lower curves gives the volume of gas collected in a given period, each curve giving the volume with one adjustment of the screw clamp or an orifice. The vertical distance of the upper curves is the effective head in inches of water, this effective head decreasing as the water runs out of the bottle. The decrease in head gives a slight curvature to the lower curves, showing that the rate of collecting the gas is not quite uniform. It will be noticed that the curves obtained with the orifice are nearer a straight line than those obtained with the screw clamp. Curve 2 is a typical curve showing the results of dirt accumulating in the narrow slit in the rubber tubing and gradually stopping the flow of water. When the gas is collected over a period of 5 hours the water flows out of the collecting bottle at the rate of about two drops per second.

If the collection is started with an effective head smaller than those shown in figure 36, the rate of collection will not be as uniform as shown by the curve in the figure.

EXPERIMENTAL DATA ON THE ABSORPTION OF CO_2 BY WATER AND BRINE.

Gases are absorbed by liquids from a mixture of gases according to their partial perssures. The amount depends upon the nature

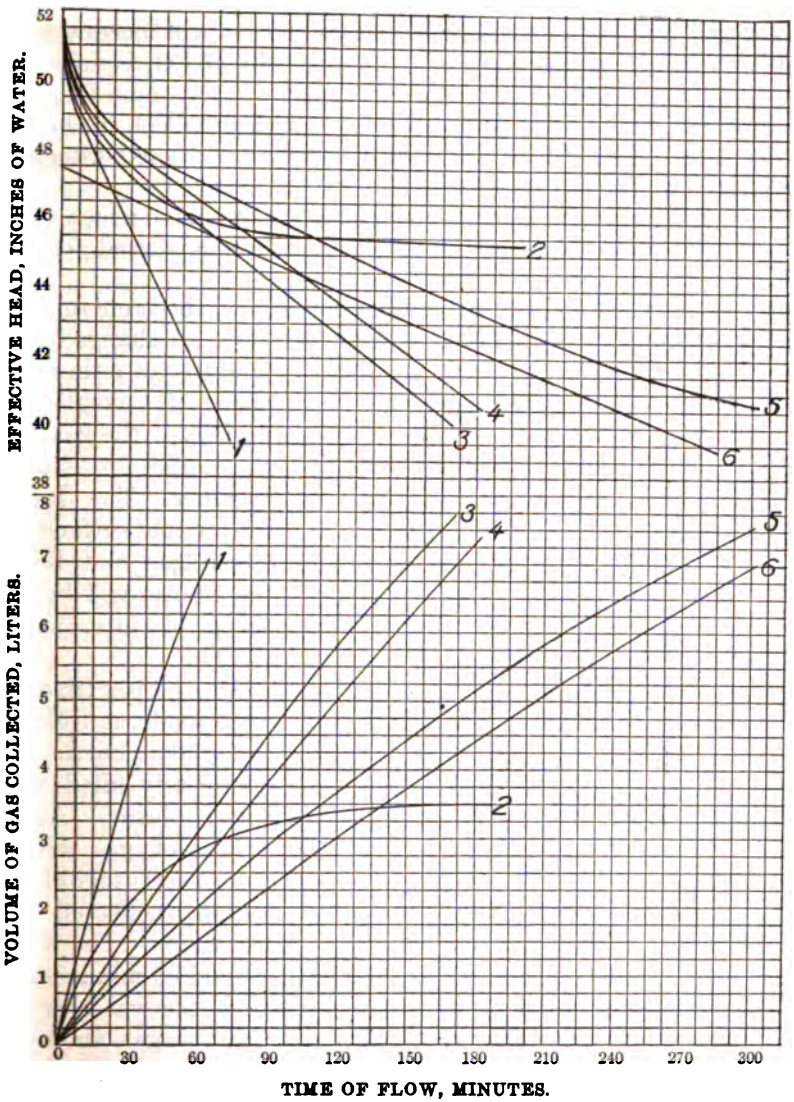


FIGURE 36.—Curves showing the uniformity of rate of collecting gas with two collecting bottles arranged as shown in figure 8. Upper curves show the change in effective head, lower curves the volume of gas collected. Curves 4 and 6 were obtained with orifice; all others with screw clamp.

of the substances and the temperature. Solids dissolved in liquids decrease the solubility of gases in the liquids, if there is no chemical action.

When flue-gas samples are being collected, the solubility of CO_2 in the liquid over which the gas is collected changes when the composition of the flue gas changes. If the liquid has been saturated with flue gas containing 10 per cent of CO_2, and a gas containing 4 per cent of CO_2 is collected over the liquid, CO_2 will pass from the liquid into the gas, and the percentage of CO_2 in the gas will increase. In a similar manner, if gas containing 10 per cent of CO_2 is collected over a liquid in equilibrium with 4 per cent of CO_2, some CO_2 will pass from the gas to the liquid and the percentage of CO_2 in the gas will decrease. These facts are shown clearly by the experimental results given in Tables 6 to 10.

The experiments were made to determine the extent to which these changes take place when water or a salt solution is used for the confining liquid.

The tests were all made under similar conditions, the same relative quantities of gas and liquid being used in each test. A change in the quantity of either will change the results, especially if the gas and the liquid are shaken together. The larger the contact surface between gas and liquid the greater will be the speed of interchange of CO_2.

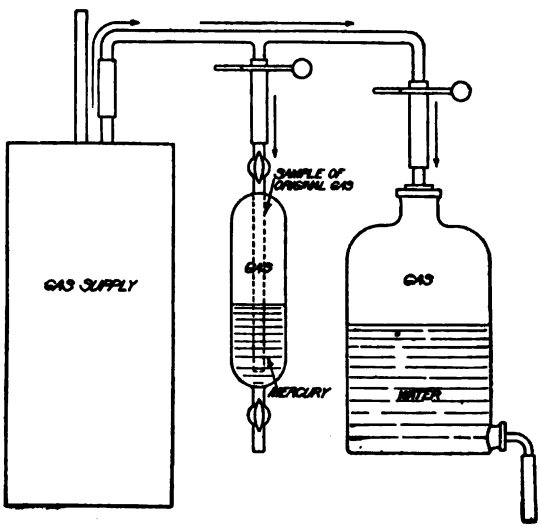


FIGURE 37.—Arrangement of apparatus for determining the absorption of CO_2 when collecting the gas over water or brine.

The experiments were made as follows: A 2-gallon bottle was completely filled with water or brine. About 1 liter of gas with a given percentage of CO_2 was then collected over the water. The water and the gas were shaken 5 minutes, then left to stand 30 minutes and again shaken for 5 minutes. With this procedure the water or the brine was brought nearly into equilibrium with the gas above it. A sample of the gas was analyzed for CO_2, and the figures obtained are the values given in the first column of the tables. The water or brine thus prepared was used in collecting a sample of gas containing either a lower or a higher percentage of CO_2 than the gas with which the liquid was previously in contact. As the gas was collected in the bottle a small part of the gas stream was led into a small gas container and collected over mercury. The arrangement of apparatus for the collection of these samples is shown in figure 37.

The collecting bottle was filled about two-thirds with gas and left standing undisturbed. The gas collected in the small gas container was of the same composition as the gas flowing into the large collecting bottle, and its composition was not affected by the mercury. Therefore its analysis gave the percentage of CO_2 in the gas as it flowed into the collecting bottle. In Tables 6, 8, and 10 this percentage is given in the third column, and in Tables 7 and 9, in the second column.

After each of 2, 4, and 21 hour periods a small gas sample was taken out of the large collecting bottle and analyzed. The percentages of CO_2 found by the analyses are given in Tables 6 to 10. In some experiments the temperature of the water in the collecting bottle was measured at the time a sample was taken for analysis. These temperature readings are given alongside the CO_2 percentages.

In some of the experiments after the gas and liquid had stood 21 hours and the percentage of CO_2 in the gas had been determined, the gas and liquid were shaken together for five minutes and the gas was again analyzed for CO_2. The results of such determinations of CO_2 are given in the second column of Tables 6 and 8.

The experiments were made with water with a 10 per cent brine solution and with saturated, or about 35 per cent, brine. The 10 per cent brine solution was prepared by dissolving 1 pound of common salt in 9 pounds of water. The saturated, or about 35 per cent, brine was obtained by dissolving all the salt that would go into solution—about 3½ pounds of salt per 10 pounds of water.

Table 9 gives the data on the absorption of CO_2 when the gas was bubbled through the liquid, with a constant effective head, as shown in figure 10. The duration of bubbling the gas through the liquid is given by the last column of the table.

Table 10 gives the data from experiments made to determine the effect of shaking the gas and water or brine together. Gas of given composition was collected over the liquid in a bottle, the collection lasting about five minutes. One sample was taken and analyzed immediately after collection. The bottle was then shaken for five minutes and the sample again analyzed for CO_2.

In all the experiments the same quantity of gas and liquid was used; that is, two-thirds of the volume of the bottle was gas and one-third was water.

TABLE 6.—*Data showing the tendency of water to absorb and give out CO_2.*

Percentage of CO_2 in gas after contact with water.	Temperature of water.	Percentage of CO_2 in original gas.	Percentage of CO_2 in gas after standing over water for— Two hours.	Temperature of water.[a]	Four hours.	Temperature of water.[a]	Twenty-one hours.	Temperature of water.[a]	Percentage of CO_2 in gas after standing 21 hours and being shaken 5 minutes.	Temperature of water when gas was analyzed.[b]
	°C.			°C.		°C.		°C.		°C.
5.0	.....	8.9	8.8	.....	8.6	.....	7.9	.....	.....	.....
5.0	.....	11.6	11.3	.....	11.0	.....	9.2	.....	.....	.....
8.0	.....	11.9	11.7	.....	11.8	.....	10.9	.....	.....	.....
4.0	.....	15.0	[b] 14.9	.....	13.6	.....	10.5	.....	.....	.....
7.7	.....	4.4	4.6	.....	4.8	.....	5.4	.....	.....	.....
17.0	.....	2.7	3.1	.....	3.5	.....	6.3	.....	.....	.....
4.5	21	10.3	10.1	22	9.9	23	8.8	22	8.0	22
4.6	29	10.8	10.8	30	10.1	32	9.3	27	8.6	27
5.0	23	13.0	12.9	24	12.6	25	10.6	20	9.2	20
6.6	27	8.8	8.7	29	8.5	29	7.9	27	7.9	27
10.1	28	3.9	4.2	30	4.4	31	5.2	22	5.9	22
12.0	24	5.6	5.7	24	5.9	25	6.7	26	8.3	26

[a] Temperature was recorded only where given in the table.
[b] Gas had stood over water only one hour.

TABLE 7.—*Data showing the tendency of 10 per cent brine to absorb and give out CO_2.*

Percentage of CO_2 in gas after contact with 10 per cent brine.	Percentage of CO_2 in original gas.	Percentage of CO_2 in gas after standing over 10 per cent brine for— Two hours.	Four hours.	Twenty-one hours.
3.9	8.9	8.9	9.0	8.2
4.0	15.0	[a] 15.0	14.5	12.7
5.0	11.6	11.5	11.5	10.2
8.0	11.9	11.8	11.6	11.0
10.6	4.4	4.5	4.6	6.7
17.0	2.7	2.7	3.1	4.9

[a] Gas had stood over brine only one hour.

TABLE 8.—*Data showing the tendency of saturated brine to absorb and give out CO_2.*

Percentage of CO_2 in gas after contact with saturated brine.	Temperature of water.	Percentage of CO_2 in original gas.	Percentage of CO_2 in gas after standing over saturated brine for— Two hours.	Temperature of water.	Four hours.	Temperature of water.	Twenty-one hours.	Temperature of water.	Percentage of CO_2 in gas after standing 21 hours over brine and then shaking for 5 minutes.	Temperature of water.
	°C.			°C.		°C.		°C.		°C.
2.5	21	10.3	10.3	22	10.2	23	9.7	22	8.1	22
5.5	23	13.0	13.1	24	13.0	25	12.0	20	11.3	20
10.4	28	3.9	4.0	30	4.1	31	4.4	22	4.5	22
12.0	24	5.6	5.8	24	5.6	25	5.9	26	6.5	26

TABLE 9.—*Data showing the effect of bubbling gas through water and brine with a constant head.*[a]

Percentage of CO_2 in gas after contact with brine.	Percentage of CO_2 in original gas.	Percentage of CO_2 after bubbling through water.	Percentage of CO_2 after bubbling through 10 per cent brine.	Time of collecting.
				Hours.
0.0	8.3	4.4	5.3	3½
4.5	13.2	7.6	8.3	3½
16.5	10.6	12.8	12.6	4
9.7	6.0	7.5	6.9	1

[a] See fig. 10 (p. 17).

TABLE 10.—*Data showing effect of shaking gas and water, or 35 per cent brine, in collecting bottle.*

Liquid shaken with gas.	Percentage of CO_2 in gas after contact with liquid.	Percentage of CO_2 in original gas.	Percentage of CO_2 after shaking gas and liquid five minutes.
Water	12.0	6.3	7.5
	7.4	11.7	10.8
	3.9	18.5	14.8
Saturated brine	11.9	6.2	7.3
	7.4	11.7	11.0
	3.9	18.5	16.7

CONCLUSIONS FROM EXPERIMENTS ON ABSORPTION OF CO_2 BY LIQUIDS.

The results of the experiments just described permit the following conclusion: With greatly varying compositions of flue gas the error resulting from absorption or giving out of CO_2 by the confining liquid may amount to 3 or 4 per cent of CO_2. The error is less with 10 per cent brine than with water and less with saturated brine than with 10 per cent brine.

Shaking the gas and the liquid together increases the absorption or giving out of CO_2 by the liquid.

The largest error is introduced when the gas is bubbled through water. Therefore this method of collecting gas should not be used.

If the percentage of CO_2 does not vary more than 2 or 3 per cent and if the gas does not stand over the liquid more than 2 hours, water may be used satisfactorily for the confining liquid. If, however, the variation of CO_2 exceeds 3 per cent and the gas stands over the liquid a long time, brine can be used to good advantage. The brine is not as convenient to handle as pure water; the water evaporates and the salt is deposited on all surfaces and mars the appearance of the apparatus.

Gas should be analyzed as soon as collected; shaking of the liquid and any change in its temperature should be avoided.

Ordinarily when collecting flue gases in the boiler room it is doubtful whether the percentage of CO_2 of the collected gas when analyzed is closer than 0.5 per cent of the gas as it enters the collecting bottle.

Considering all the possible errors that may and often do enter into the sampling and collecting of flue gas, one is justified in looking with suspicion on many of the published heat balances of boiler trials. The possible errors make the determination of radiation losses by difference in the heat balance questionable.

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JOSEPH A. HOLMES, DIRECTOR

REPORT

OF THE

SELBY SMELTER COMMISSION

BY

J. A. HOLMES

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PREFACE.

Smelter-smoke problems were among the first to receive attention by the Bureau of Mines in its endeavors to increase efficiency and lessen or prevent waste in the utilization of the mineral resources in the United States. The problems presented to the bureau included the determination of the actual economic waste involved in the escape of dust, fume, and gas from the stacks of metallurgical plants, more especially those treating sulphide ores, as well as the damage to plants and animals and the creation of a public nuisance.

The work undertaken by the bureau involved the examination of conditions in the vicinity of smelting plants and the methods adopted or on trial to prevent the loss of valuable substances in smelter smoke and to prevent damage by the constituent fumes and gases; the determination of new uses or wider uses for those constituents wasted from lack of a market or inability to recover them at a profit by existing methods; and also the laboratory study of the fundamental physical and chemical reactions of those metallurgical processes that cause smoke and fume.

As in its investigations relating to methods of increasing safety and health conditions in mines, so in its metallurgical investigations the Bureau of Mines endeavors to cooperate actively, so far as it can under the terms of its organic act, with Government and State bodies and with private organizations that are endeavoring to bring about such improvements in industrial methods and conditions as come within the scope of the bureau's purpose. Although the bureau is forbidden by law to make reports on mineral properties for private individuals, its engineers and chemists, as expert advisers for the Government, have done much work dealing with safety and efficiency in the development and utilization of the mineral resources of the country.

Moreover, the bureau has believed that much controversy and much needless and expensive litigation regarding damage to public interests by mines or by metallurgical plants can be avoided by the appointment of commissions composed of unbiased experts who, from their knowledge of the principles involved, will determine with precision the essential facts and their relation to matters in controversy and will lay down findings that, because of the manner in which they had been formulated, will be accepted as final by the parties at interest. Absolute freedom of judgment is necessary for the success of such a commission. Expert testimony produced by

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either litigant is under suspicion by the other, but scientific and technical investigations by the Federal Government or by an unbiased commission inspire confidence, and findings based on such investigations command respect.

For these reasons when, as a result of protracted litigation between the Selby Smelting & Lead Co. and the citizens of Solano County, Cal., it was decided to refer to a commission the question whether the Selby company was violating the terms of a court injunction, the Director of the Bureau of Mines, under instructions from the Secretary of the Interior, accepted the chairmanship of this commission, and various chemists and other employees of the bureau who had been or were engaged in work relating to smelter smoke were authorized to facilitate the work of the commission by carrying on incidental investigations. Under this arrangement the commission benefited by the work of skilled experts, and the Government employees gained valuable knowledge and experience without the Government being subject to any additional expenditure.

This bulletin presents the report of the commission and the papers, prepared by the various experts, which give the results of investigations undertaken by the commission and form the basis of its findings. The papers include detailed discussions of the effect of smelter smoke on vegetation, by A. E. Wells, J. W. Blankinship, and W. W. Jones, and on horses, by C. M. Haring and K. F. Meyer, and a review of local opinions, by C. B. Dutton. These papers are published essentially as presented to the parties at issue—the smelting company and the county officials—except that, in editing, certain changes of style have been made in compliance with the Government regulations and certain statements dealing with persons who were examined have been modified or stricken out, the purpose being to present all essential facts relating to the questions submitted to the commission and to omit such opinions as did not rest on provable statements.

As here assembled, the report of the Selby Commission is published by the Bureau of Mines as a contribution to the literature of metallurgical smoke in its relation to plant growth and to public health and comfort, and as an example of what is believed to be a satisfactory method of dealing with legal controversies over the damage inflicted by mining and metallurgical establishments.

J. A. HOLMES.

REPORT OF THE SELBY SMELTER COMMISSION.

FORMAL PRELIMINARY STATEMENT OF THE MEMBERS OF THE COMMISSION.

The People of the State of California, Selby Smelting & Lead Co. (a corporation), *ss:*

GREETINGS.

The Selby Smelter Commission has the honor to submit, herewith, its conclusions, findings, and recommendations as provided for in the stipulation filed in connection with the decree of the superior court of Solano County, Cal., dated July 16, 1908, entitled:

The People of the State of California, *Plaintiffs*,
v.
Selby Smelting & Lead Co. (a corporation), *Defendant.* } No. 2980.

The commission may be permitted to express its earnest hope that the litigation which comes to an end with the findings and recommendations herein set forth will be considered by both parties to the action as definitely and equitably decided.

The commission trusts that its work will show the value of the commission form of settlement and that its work will serve as a precedent to be followed in disputes relative to technical subjects. If the work of the commission is productive of a tendency on the part of technical litigants to avoid the use of the courts for the settlement of disputes it will not have been done in vain. Such tendency will surely grow and ultimately such differences will be arbitrated by technically trained men without recourse to the courts of law.

Appended to the report of the findings of the commission are to be found the detailed reports covering the several lines of inquiry and investigation carried on by the commission and upon which its findings are based, and also a detailed statement of the fiscal affairs of the commission. A word of explanation is necessary in regard to the fiscal statement. While each party to the litigation has agreed to bear one-half of the expense of the investigations of the commission, it will be noted that the Selby Smelting & Lead Co. is credited with $21,000, while Solano County is credited with but $6,000. In order that the investigations of the commission might go forward without interruption the Selby Smelting & Lead Co. has generously supplied funds at the times they were needed. This assistance has been

accepted by the commission in the full belief that Solano County, in accordance with its agreement, would reimburse the Selby Smelting & Lead Co., through the commission, by appropriating funds at the earliest possible moment to meet its obligations in this connection.

Respectfully,

(Signed) J. A. HOLMES.
EDWARD C. FRANKLIN,
RALPH A. GOULD.

FORT BAYARD, N. MEX.,
November 5, 1914.

ORIGIN, PURPOSE, AND PERSONNEL OF THE COMMISSION.

The Selby Smelter Commission is a body organized for the determination of questions of fact and other matters concerned with certian injunction proceedings at issue between the people of the State of California and the Selby Smelting & Lead Co. Authority for the organization of the commission is found in a stipulation filed in the superior court of Solano County, Cal., as a portion of the record of the case.

THE INJUNCTION DECREE.

On March 14, 1905, the district attorney of Solano County, acting upon complaints which had been made by the residents of the city of Benicia and its tributary country, all of which area is located within the boundaries of Solano County, brought an action in the superior court of Solano County praying for an injunction which would restrain and enjoin the Selby Smelting & Lead Co. from permitting the smoke from the Selby smelter to blow over and upon the territory above mentioned. The offending smelter is situated near Vallejo Junction, Contra Costa County, Cal., about 5 miles directly west of the city of Benicia and about 1 mile directly south of the nearest point of land included in the area in which the complaints arose.

On October 23, 1905, the Selby Smelting & Lead Co. entered a demurrer to the complaint. The demurrer was overruled by the court on February 6, 1906. Answer to the complaint was thereupon filed by the company on May 19, 1906, and on August 7, 1906, the case was brought to trial before the court, jury having been waived by both parties to the suit. The case was lengthy and involved the taking of much testimony, both lay and expert, so that the court's opinion was not filed until late in October, 1906, and it was not until April 22, 1907, that the findings of fact and conclusions of law were filed by the court. On July 16, 1908, judgment was rendered in favor of the plaintiff. The judgment of the court follows:

IN THE SUPERIOR COURT OF THE COUNTY OF SOLANO, STATE OF CALIFORNIA.

The People of the State of California, *Plaintiffs*,
v.
Selby Smelting & Lead Co. (a corporation), *Defendant*. } No. 2980.

JUDGMENT.

This cause came on regularly for trial, the parties appearing by their attorneys. A trial by jury having been expressly waived by counsel for the respective parties, the cause was tried before the court, whereupon testimony, documentary and oral, on the part of plaintiff and defendant, was introduced; the evidence being closed, the cause was submitted to the court for consideration and decision, and after due deliberation thereon the court delivers its findings and decision in writing, which are filed, and orders that judgment be, and be entered in accordance therewith.

Wherefore, by virtue of the law and the findings aforesaid, it is ordered, adjudged, and decreed that the operation at its works, for the reduction of ores, upon the Straits of Carquinez, near Vallejo Junction, in the County of Contra Costa, in said State of California, as conducted by defendant in liberating at and therefrom into the air sulphurous and other injurious and noxious gases and smoke, and also smoke and fumes and gases, so in the findings of fact herein to be offensive to the senses so as to interfere with the comfortable enjoyment of life and property in the manner, and to the community and neighborhood, as in the said findings of fact set forth and described, generated or produced by such operations without condensing or otherwise disposing of the same or eliminating the same before reaching the open air, is as to said city of Benicia and said portion of said Solano County mentioned and referred to in said findings, a public nuisance for the period commencing at or about the middle of the month of March of each year, for eight months in each and every year, including the latter half of said month of March.

It is further ordered, adjudged, and decreed that said nuisance be abated by said defendant, and that defendant and its officers, agents, servants, and employees, and each and all of them, are hereby perpetually enjoined and restrained from roasting, burning, smelting, refining, or treating any ores, or their products, at or by or in the operation of said works, for and during the period in each year commencing at or about the middle of the month of March in each year until the middle of November in each year, including the latter half of said month of March, during which period said nuisance exists, without condensing or otherwise disposing of or eliminating, before reaching the open air, all said sulphurous and other noxious and injurious gases and smoke, and also said smoke, fumes, and gases so found to be offensive to the senses, generated or produced by said works, or the operation thereof, and in such manner so that the same will not reach the open air and will not be blown or carried by said winds over or into or upon the city of Benicia and that portion of Solano County beginning at said city of Benicia and running in a westerly direction to a point in said Solano County situated upon the Straits of Carquinez where the Napa River flows into said Straits of Carquinez.

Dated this 14th day of July, 1908.

L. G. HARRIER,
Judge of said Superior Court.

Entered this 16th day of July, 1908.

G. G. HALLIDAY, *County Clerk.*

On July 25, 1908, the defendant company gave notice of intention to move for a new trial. Motion for new trial of the cause was denied by the court on November 22, 1909, and on December 2, 1909, an

appeal was taken to the supreme court of the State from the order denying the motion for a new trial. On June 12, 1912, the judgment of the trial court was affirmed by the supreme court of the State.

CREATION OF THE COMMISSION.

During the period of time covered by the numerous steps of the legal proceedings much complaint was made by residents of the area referred to, and after the judgment was pronounced numerous and emphatic complaints from the citizens of the territory were made to the effect that the injunction was being violated.

The Selby Smelting & Lead Co. in the meantime had made very considerable and commendable progress towards abating such objectionable smoke as they discharged into the air at the time of the trial. During the spring of 1913 complaints were again made that the nuisance existed. The company maintained that they had abated the nuisance. In order to avoid the expenses to both parties to the litigation attendant upon a trial of the smelter company for contempt of court, conferences of the attorneys representing both sides developed a desire to submit the question of fact as to the violation of the injunction to a board of technically trained men deemed by both sides to be qualified to act in such a capacity. The result of the conferences was the filing of a stipulation in the record of the action providing for such a board.

The stipulation was filed on March 16, 1913, and is as follows:

IN THE SUPERIOR COURT OF THE STATE OF CALIFORNIA IN AND FOR THE COUNTY OF SOLANO.

The People of the State of California, *Plaintiffs*, *v.* Selby Smelting & Lead Co. (a corporation), *Defendant.*	No. 2980.

STIPULATION.

Whereas, complaint has been made to the board of supervisors of the above-entitled county that the decree hereinbefore entered is being violated by the above-named defendant, and

Whereas, the above-named defendant claims and asserts that it is not violating the said decree but is operating its plant in all respects in accordance therewith, and is not doing any injury thereby, and

Whereas, the determination of the said question by the courts would involve a large expense and long delay in the determination of the quantity of deleterious and injurious fumes and gases, if any, emitted by the defendant, and would necessitate the taking of measurements and the collecting of a large amount of data, and

Whereas, in the opinion of both the parties hereto said question can be more easily investigated by a board of impartial experts qualified by their training and experience to consider questions of this nature.

Now therefore, for the purpose of facilitating the determinations of the truth as to the controversy above described, and to fix and determine the conditions under which the defendant's plant may operate,

It is hereby stipulated and agreed by the above-entitled parties that a commission consisting of J. A. Holmes, W. F. Snow, and Ralph A. Gould be, and they are hereby, agreed upon and appointed as a board of experts, which board shall, for such a period of time as may be required therefor not exceeding eight (8) months from the date hereof, investigate and report to the parties hereto concerning the operation of the defendant's plant with respect to the emission of deleterious or injurious fumes, if any, therefrom, and the effect, if any, thereof upon the territory alleged to be affected by the said plant in the county of Solano, including the city of Benicia, and also with respect to the methods, devices, or processes employed by the said defendant to reduce, minimize, or otherwise render less the said injurious fumes.

If the board shall find that the above-named defendant's contention is true and that it is not at the present time operating its plant in a manner to violate the decree heretofore duly given and made herein, it shall make a finding to that effect.

If the board shall find that the defendant is operating its plant in such manner as to produce smoke, fumes, and gases offensive to the senses, or destructive to the property of people residing in said district of Solano County, or so as in any manner to be violative of the said injunction, it shall make a finding to that effect. It shall also proceed to determine the specific amount of sulphurous or other fumes, smoke, or gas, if any, which the defendant may properly emit into the atmosphere without violating the terms and conditions of the said injunction, and shall also designate the means, apparatus, or process to be used and method of operation to be followed by the defendant in the operation of its plant, which in the opinion of the said commission is best calculated to carry out the tenor and effect of such determination. The apparatus to be used shall conform to the most approved, scientific, and practical process applicable to works of the character of said defendant, and the method of operation to be followed shall be such as to cause the necessary elimination or reduction in volume and character of the said fumes, smoke, and gases.

The defendant thereupon agrees not to emit into the atmosphere a greater amount of the specific fumes or gases than is permitted by the finding of said board, and agrees to use the means or method of operation and the apparatus designated by said board, or some other apparatus or method of operation which shall produce the same result so far as the specific amount of such noxious fumes or gases is concerned.

The said board may also from time to time during the said period make such inquiries, employ such experts, or otherwise fully advise itself of the conditions and matters under consideration.

The said board may from time to time during the said period make regulations as to the mode and method of operation of the plant of the said defendant and the amount of smoke, fumes, and gases to be emitted, which regulations shall and will be followed by the said defendant in the operation of such board as to the matters hereinbefore set forth.

The said parties agree that if at any time during the investigation and report upon operation of the said plant and the matters hereinbefore mentioned such board shall find as a fact that the operation of such plant is being conducted so as to be violative of the provisions of said injunction and to cause a public nuisance notice thereof may be given to the said parties hereto of such determination. Until such notice is given the operation of its works by the defendant, if in conformity to any regulations or directions of the said board, shall not be deemed to be violative of the said decree.

Pending such examination by said board defendant agrees to further increase the amount of material which is shipped elsewhere for roasting so that not to exceed 600 tons per month of sulphurets will be roasted instead of an amount of 2,400 tons, which formerly were handled monthly at said plant.

It is further agreed that the period of eight months hereinbefore referred to shall not be considered as part of the period during which the statute of limitations may

run as to any or all actions arising out of the operation of the defendant's works, whether for public or private nuisance or public or private injury or damage, and the said period of eight months shall be construed to be added to any period in determining when any existing cause of action may be barred by the running of the period of such statute.

It is further agreed that in event that either or any of the said persons appointed upon said board of arbitration are for any reason unable to act, or if after appointment they or either of them are unable to continue hereunder, that the attorneys for the plaintiff shall designate the persons who shall be substituted in his or their place.

By entering into this stipulation the defendant does not concede that it is causing to be emitted from its said works any deleterious or injurious fumes.

Dated March 15, A. D. 1913.

(Signed) T. T. C. GREGORY,
J. A. RAINES,
Attorneys for Plaintiffs.

(Signed) CHICKERING & GREGORY,
Attorneys for Defendant.

ORGANIZATION OF THE COMMISSION.

It developed after filing the stipulation that Dr. W. F. Snow was unable to serve upon the commission, and by mutual consent of the two parties to the action, through their attorneys, Edward C. Franklin was appointed as third member of the commission. Dr. Franklin was at that time director of the chemical laboratories of the United States Public Health Service in Washington, D. C., but later returned to his position as professor of organic chemistry at Leland Stanford Junior University. His acceptance of the appointment completed the full membership of the commission.

On May 22, 1913, the commission was formally organized as the Selby Smelter Commission, with the following personnel:

J. A. Holmes, Director of the United States Bureau of Mines, chairman of the commission.

Edward C. Franklin, professor of organic chemistry, Stanford University.

Ralph A. Gould, chemical engineer, San Francisco, secretary of the commission and in immediate charge of investigations.

In session the commission outlined its plan of study and investigation and began at once the active work of determining the questions involved in the stipulation and the injunction decree.

The active work of collecting data began about June 1, 1913, and was finished about September 1, 1914, a period of about 15 months. The tabulation, correlation, and study of the data has consumed the time from September 1 to the date of this report. Approximately $26,000 has been expended by the commission in the collection and presentation of the data. The commission has exerted its best endeavors to make this work both thorough and comprehensive.

SCOPE OF THE COMMISSION'S WORK.

The stipulation requires a report and finding by the commission on points which are summarized as follows:

1. Is the plant of the Selby Smelting & Lead Co. being operated in such a manner as to violate the decree of the court dated July 16, 1908?

2. If the defendant company is violating the decree, what is the extent of the violation?

3. If the defendant company is violating the decree, what remedial methods can be taken by the defendant to avoid a violation of the decree?

4. If the defendant company is not violating the decree, under what conditions must the plant operate so as not to violate the decree in the future?

The stipulation confers authority upon the commission to make such investigations as it may deem necessary for a just and equitable solution of the questions submitted, and gives the commission power to make recommendations, which are binding upon the defendant company for the future operation of the plant, with respect to the discharge of material into the atmosphere.

The commission entered upon its work with the distinct understanding of all parties concerned that the general good could be best conserved by a broad interpretation of the power delegated to the commission by the stipulation and the maintenance of a strictly neutral position and point of view. As contributing in no small degree to the establishment of the neutral position of the commission, should be mentioned the agreement of both parties to the legal proceedings to share equally in the cost of the investigation.

The members of the commission were actuated to serve in the belief that this method of settlement and the results obtained would serve as a precedent to contemplated future litigation concerning technical matters, and would mark a forward step in the elimination of costly and usually unsatisfactory court procedure.

THE COMMISSION'S STAFF.

The conduct of such a series of investigations as was desired required the services of a considerable number of trained scientific and technical men. In so far as it has been possible, each investigation has been carried out by the cooperation and collaboration of at least two specialists in that particular field. In some cases more than two men have collaborated. Throughout the entire work of the commission difficulty has been experienced in obtaining men who, in the opinion of the commission, were qualified to undertake the work. Without exception, all of the men in charge of work have

been thoroughly trained in science and technology; they have all had considerable experience in the practice of their especial lines of training, and no one of them has been influenced by partisan interest in the results.

Through the courtesy of Dr. Thomas Forsyth Hunt, dean of the college of agriculture of the University of California, the cooperation of several of the staff of the college of agriculture was obtained. The commission was fortunate in obtaining this cooperation, because of the especial experience of the collaborators. Owing to the "quasi legal" character of the commission, as distinguished from the activities of a board acting in behalf of a single party, Dean Hunt extended the facilities of his department and the services of his staff to the commission without compensation.

The cooperation of the department of physiology of the University of California was also obtained, through the courtesy of Dr. F. T. Gay, professor of pathology of the University of California.

Through the courtesy of the honorable the Secretary of the Interior, the facilities of the United States Bureau of Mines and its staff of experts were placed at the disposal of the commission, and some of the work undertaken was begun at their suggestion, while much of the work of the commission's staff was performed in the Bureau of Mines laboratories at San Francisco.

The cordial thanks of the commission are extended to Dean Hunt, Dr. Gay, and the honorable the Secretary of the Interior. The especial thanks of the commission are due to Dr. F. G. Cottrell, chief chemist, and Dr. L. H. Duschak, chemical engineer, of the United States Bureau of Mines, for their generous and valuable cooperation. The commission desires to extend its thanks to all of the staff for their painstaking and willing assistance and service.

The investigations of the commission were carried on by the following staff:

Ralph A. Gould, in general charge of investigations in consultation at frequent intervals with the other members of the commission.

Arthur E. Wells, metallurgist and chief chemist in charge of smelter investigations and field work.

C. B. Dutton, special legal agent, United States Bureau of Mines.

J. W. Blankinship, plant pathologist.

Wyatt W. Jones, plant pathologist.

R. W. Doane, professor of entomology, Leland Stanford Junior University.

Charles F. Shaw, professor of agronomy, college of agriculture, University of California.

E. E. Free, agronomist and soil expert.

C. M. Haring, D. V. M., professor of veterinary science, college of agriculture, University of California.

Karl F. Meyer, D. V. M., professor of bacteriology and protozoology, college of medicine, University of California.

The Chemists' Club Library, bibliographers.

G. C. Bartells, jr., chemist, United States Bureau of Mines.

N. M. Porter, clerk of the commission.

Assisted by the following:

G. N. Libby, chemist and assistant metallurgist.

H. H. Bartells, chemist.

Bryant S. Drake, chemist.

J. D. Enas, chemist.

H. L. Long, chemist.

R. J. McKay, chemist.

R. W. Noreen, chemist.

E. P. Roleson, chemist.

Ralph W. Brown, assistant to agronomists.

William LaGrange, assistant to veterinarians.

J. H. Collier, statistical assistant.

D. C. Allen, field assistant.

H. G. Asseltine, field assistant.

I. Dickson, field assistant.

D. L. Hollingsworth, field assistant.

J. W. Norton, field assistant.

L. L. Patterson, field assistant.

PRELIMINARY INVESTIGATIONS OF THE COMMISSION.

Fully realizing the importance of the questions at issue and the results to be obtained by an impartial review and investigation of the subject as a whole, the commission decided to take nothing for granted in its collection of data concerning the area affected, but to obtain information at first hand, and thereby to be in a position to draw its conclusions impartially and to present its findings without bias.

A canvass of the situation as it existed at the time of the organization of the commission was made, and a preliminary plan of campaign was mapped out. This plan included, first, a review of the legal record of the case; second, a review of the scientific and technical data collected by the smelter company; and, third, a review of the scientific and technical data collected by Solano County.

From the information collected in this preliminary inquiry the commission concluded that much of the previous work of each of the parties to the suit had been done at cross purposes, and that little real information was available upon which to base a conclusion which would be equitable or scientifically justified.

Many of the complaints relative to conditions had been made in good faith by the residents of the area affected, upon the belief that

"smelter smoke" was the cause of the general lack of vigor displayed by the vegetation and was the main factor in the maintenance of an offensive smell in the area, which in this and other reports is designated as the smoke zone. Many of the answers given by the company to these complaints were simple denials that the trouble, whatever it was, was due to "smelter smoke." Some effort had been made by the company, at various times, to determine the specific causes of some of the registered complaints, but, as often happens in cases of this sort, the data collected were obtained for possible use in the defense of damage cases, and were, as a consequence, not freely discussed with the complainant for his enlightenment. Much crimination and recrimination had been indulged in to the detriment of the good will which should exist between industrial plants and the residents of the country surrounding them, and to the delay in reaching a definite, if not an amicable, settlement of the differences which existed.

While the large majority of the complainants of the smoke zone are undoubtedly honest in their belief that the smelter is the cause of many of their misfortunes there can be no doubt that others in ascribing their troubles to smelter smoke are actuated by ignoble motives. In the absence of positive and accurate knowledge on the subject, and with inability to properly correlate his observations, the layman can not be expected to arrive at true causes of obvious effects which, even to experts trained to observe and correlate their observations, are not only difficult, but sometimes impossible of accomplishment.

The farmer, not familiar with technical or scientific matters, observing peculiar markings on his crops in the vicinity of a smelter, very naturally blames the smoke as the cause of trouble. He may know nothing of the quantity or nature of the material handled by the smelter; he may not be able to identify the "smoke" when he smells it; but he does know that in many cases smelters are a cause of damage to the vegetation in the areas immediately surrounding them. It is, therefore, much easier for him to blame the smelter than it is to investigate carefully and learn positively the actual cause of the trouble which he sees. It is also too much to expect that the average farmer will find the time to devote to a detailed study of plant diseases and the various natural elements that constantly menace his crops and trees. When the average farmer has really become familiar with the subject, he is most reasonable and guarded in any statements he may make that "smoke" is responsible for all of his ills. With such an estimate of the usual intelligent citizen of this country, the commission has undertaken its labors in a spirit of helpfulness to both the farmer and the smelting company.

Looking at the questions as presented in the stipulation from a broad point of view, the commission has done some work that might have been left undone but for its desire to cover all phases of the subject with a view to the general good, and the commission feels that all its investigations have been conducted with a fully premeditated objective point as a goal. The commission has been as much interested in causes which can in no way be attributed to the smelter, or due to its operations, as it has in causes which are directly traceable to the smelter and due to its operations. The commission feels that it has investigated thoroughly and in such a manner as to throw a maximum of light on every question of real or fancied damage or cause of damage, nuisance or cause of nuisance which exists in the area, in so far as the two parties to the suit are concerned. This has required extended study and investigation along many divergent lines of inquiry.

The smelter is enjoined from operating in such a manner as to be a nuisance. The questions naturally arise—What conditions are necessary of fulfillment to produce a nuisance from the smoke of the Selby smelter? What conditions exist in the affected area? Do the existing conditions correspond with the required conditions?

It has been a matter of some difficulty for the commission to fix in its own mind just what conditions constitute a nuisance, as implied by the injunction decree and stipulation. Realizing the inalienable right of all persons to the peaceful enjoyment of life and property, the commission has endeavored to be most liberal in its construction and interpretation of the meaning of the word "nuisance."

Approaching the subject from this point of view, the commission undertook to determine the conditions which are necessary in order that the emanation from a smelter shall annoy or give trouble to persons or things or do injury to them. To determine these, it is necessary to know first and foremost the constituent parts of smelter smoke. Inasmuch as smelters vary in the kind of materials handled and, as a consequence, in the kind of smoke discharged, it is necessary to make inquiry into the composition of the smoke of the smelter concerned in this proceeding.

THE ATTITUDE OF THE RESIDENTS OF THE SMOKE ZONE.

For the purpose of informing itself on the attitude of the residents of the smoke zone in the matter of the existence of a nuisance or the existence of possible injury to crops and animals in the area, the commission personally interviewed a number of the residents of the smoke zone and availed itself of the services of C. B. Dutton, special legal agent of the United States Bureau of Mines, for an extended inquiry.

By this investigation it was sought to determine to what extent the elements of influence and suggestion entered into the complaints from the residents of the smoke zone and the feelings of the residents as to the existence of such nuisance.

Mr. Dutton was commissioned to interview the residents of the smoke zone in as thorough a manner as possible and to obtain their ideas as to the existence of a nuisance. He was directed to talk freely with the citizens concerning the aims and purposes of the commission, to give all the information he could as to any specific questions propounded to him, and to establish, in every possible way, a cordial relationship and spirit of helpfulness between the residents of the area and the commission and its agents or employees. Mr. Dutton's task consumed a period of about six weeks, during which time he interviewed 169 individuals. This number comprised the greater proportion of the farmers of the smoke zone. Those farmers who were not interviewed could not be found at home nor could arrangement be made to meet them by appointment. The remainder of the interviews were had with persons in all walks of life in the city of Benicia. The number of residents of the city personally interviewed was 135.

It was developed by Mr. Dutton that considerable misunderstanding obtained in the area as to the work of the commission, its aims and purposes. With the possible exception of a few radicals, it is believed that the farmers of the smoke zone, as a result of Mr. Dutton's efforts, have been brought to understand that the commission has been working in their interest quite as much as in the interest of the smelter company, and that the results of its deliberations will be founded upon facts and conditions as they actually exist.

The opinions expressed by the residents of the smoke zone, as to the existence of a nuisance and injury from the smelter smoke, vary from the extreme of unreasoning radicalism to entire indifference. By far the greater number of persons interviewed have given honestly derived opinions, usually accurately expressed, and full credence is given to their statements. The more radical, however, have made statements that are so obviously at variance with what the conditions must have been, and their opinions are so palpably colored by motives of cupidity, that their statements are of no value in passing judgment on the attitude of the residents as a whole.

A considerable amount of the nuisance that has been claimed by the residents of the area to have existed in the past and to some extent to be existent at the present time has without doubt been due to a condition brought about by suggestion. It is well known that by continued reiteration a statement eventually becomes more or less fixed and magnified in the mind of the person who makes the reiteration, until the person really believes that the conditions said to exist do exist. How much of the honestly expressed opinion is

due to this element it is impossible to say, but that it is present is shown by the fact that no agreement, worthy of the name, can be found in the statements of many of the persons interviewed as to the conditions which have obtained at any given period within the area. No concordance of opinion as to any definite time or times when the smelter smoke was "bad" or "very bad" or "awful" or "not very bad" was observable in the statements made. The fact that some of the residents observe it at any given period and others do not could be accounted for by the well-known fact that some persons are more susceptible to certain odors than are others. In a community of 3,000 people, however, it is quite unlikely that an odor of any kind could be present to a degree sufficient to establish its presence as a nuisance if only 80 persons in the 3,000 could detect it, and detecting it, insist that it was present in sufficient amounts to be considered a nuisance.

There are two classes of odors that have been ascribed to "smelter smoke" by the residents of the smoke zone. The one is undoubtedly that due to the sulphur dioxide that exists in smelter smoke and the other is just as surely that of certain products resulting from the refining of petroleum, the so-called "oil smell." In the descriptions of the odors they have experienced from time to time, and in detailing the sensations produced by those disturbing odors, many of the persons interviewed have described the odor of the one class and the symptoms produced by the other class, and vice versa. Others have described the presence of smelter smoke when the existing atmospheric conditions were such as to absolutely preclude the presence of an odor from either smelter smoke or oil products. They have also declared the presence of smelter smoke at times when the analysts of the commission, all trained men and thoroughly familiar with both odors, not only could not detect the odor by the sense of smell, but could not detect measurable quantities of sulphur dioxide in the atmosphere by chemical analysis with the most delicate of methods.

Concerning that part of the alleged nuisance that is caused by the presence of objectionable and ill-smelling gases, the consensus of opinion of the residents of the smoke zone is that there is slight, if any, objection at the present time to any pollution of the atmosphere by "smelter smoke." Under extreme conditions and to especially sensitive persons, "smelter smoke" may occasionally be smelled in the area, but to the fair-minded person such occasional occurrences do not prevent the enjoyment of life, nor are they detrimental to the health of the community. As to the conditions that existed prior to the issuance of the injunction decree, or indeed prior to the signing of the stipulation whereby the commission was organized, nothing can be said in this report except the hearsay and unsupported state-

ments of the residents of the smoke zone. From these statements it is possible to believe that previous years might have shown periods when the smelter smoke was smelled for longer periods of time and possibly more often; but, in the light of the investigations of the commission, it is highly improbable that such was actually the case, as the output of sulphur dioxide from the smelter, as will be discussed later, has gradually increased for the past five years.

Concerning that part of the nuisance claimed to exist that is caused by or made up from damage to plant and animal life, the consensus of opinion of the residents of the smoke zone is that at the present time the smelter is doing no damage. Some of the farmers of the smoke zone, however, feel that even now there are times when damage is done to stock and that occasional injury results to plant life. The major part of the agricultural community hold that the accumulation of damage to the land through the years when damage was claimed to have been great, constitutes a positive handicap to profitable working of their farms at the present time. The almost universal belief of the farmers is that the soil has been poisoned by the smoke. There is a strong feeling that horses were badly affected by the smoke up to three or four years ago, and, although no new cases seem to be developing, the old ones have not recovered, and to that extent a nuisance is maintained by the smelter at the present time. The fact that the smelter company has paid claims for animals, where death was reputed to be caused by smelter smoke, without investigation of the cases, is undoubtedly responsible for some of this feeling. The above must not be construed into an intimation that damage has not been done to animals in the past. Such action on the part of the smelter company is more reprehensible than the conduct of those residents of the smoke zone who insist that they have suffered damage, but are not willing to permit investigations which will positively establish such damage. The policy that "buys off" trouble, as the most expedient commercial method for abating it, has been responsible for much of the smelter litigation of this country and the intense ill-feeling that unfortunately exists toward smelters in many smelter communities. The principle that right is on the side of the man with the biggest guns is fast becoming an obsolete idea in modern business and is being replaced by equity and open and above board dealings.

CONDITIONS AT THE SELBY SMELTER.

SMELTER SMOKE.

The smoke of the Selby smelter is composed of three different classes of material—dust, fume, and gases. The dust consists of solid particles of mineral substances or compounds which are given

off during the metallurgical operations. These particles are always in the form of solids, as distinguished from liquids and gases. The fume consists of minute particles of solid matter or liquid matter, or both, which are evolved through the metallurgical processes in the form of gases or vapors and which are subsequently condensed to solids or liquids by reason of the changes of temperature to which they are subjected in their progress through the furnaces and flue system of the plant. Except atmospheric air, which constitutes over 95 per cent of the volume, the gases which are present in the smoke have been evolved by the metallurgical process as gases and remain in the gaseous condition throughout their progress through the furnaces and flue system of the plant.

The dust, being solid matter, is visible to the eye when it issues from the stacks of the smelter into the atmosphere. The fume, provided the temperature at the top of the stack is sufficiently low, is also visible to the eye when it emerges from the stacks. If the temperature is not sufficiently low to condense the fume from its gaseous and invisible condition as it issues from the stack, contact with the atmosphere soon accomplishes the condensation, and the fume becomes visible.

The gaseous constituents of the smoke are invisible at all times and always exist as gas. The constituents of Selby smelter smoke that may possibly contribute to a nuisance or produce injurious effects within the smoke zone are sulphur dioxide, which is present in the invisible portion of the smoke to a maximum extent of 1.5 per cent, compounds of lead, arsenic, and sulphur trioxide, and flue dust, which make up the greater portion of the visible constituents of the smoke.

For a number of years after the operations of the present smelter began little attempt was made to eliminate or recover the constituents of the smoke that made it visible, although it was known that the dust and fume contained substances that were of monetary value.

Plate I fairly represents the general appearance of the smelter prior to 1905, although taken on a day during the past year when the smelter, at the request of the commission, returned to its practice of the period before 1905.

BLAST-FURNACE SMOKE.

As progress in the science of metallurgy was made it came to be realized by the smelting company that efficient and profitable operation of the plant demanded that as much as possible of this visible element of the smoke be saved. It was learned, too, that certain of the constituents which made up the visible portion of the smoke were of such a character as to be injurious to animals which lived in an atmos-

phere sufficiently contaminated by this visible element of the smoke or which fed upon forage upon which this dust and fume had been deposited in sufficiently large amounts. The particular substances which cause this injury are the compounds of lead and arsenic existing in the smoke. Whether or not as a result of a desire to operate efficiently or whether as a result of the filing of the suit for injunction, perhaps as a result of both, the smelting company in March, 1908, completed the installation of an apparatus that was designed to eliminate the visible smoke given off from the stack into which the blast-furnace smoke was discharged. This installation,[a] known as a bag house, operated successfully, eliminating all of the visible portion of the blast-furnace smoke, so that from this stack only invisible gases issue at the present time.

Plate II, *A*, and Plate II, *B*, illustrate the conditions of the blast-furnace stack before and after the installation of the bag house, and Plate II, *C*, shows a general view of the smelter stacks as they appeared subsequent to 1908.

PARTING-RETORT FUMES.

One of the metallurgical processes of the smelter used in connection with the refining of gold and silver produces large volumes of the fume of sulphuric acid. The vapor or fume from sulphuric acid when in its concentrated form is extremely destructive to animal and vegetable tissue. Fortunately for the smelter and for the surrounding country these fumes are very heavy, and, except in high wind, do not carry far from the point at which they may be discharged into the atmosphere. Unfortunately for the smelter the avidity with which these fumes attack all sorts of organic matter and most metals made their elimination impracticable. In order to carry on that part of the refining process in which sulphuric acid is used these fumes were discharged into a low stack to prevent, as far as possible, their wide dissemination and to confine them to an area immediately contiguous to the smelter itself. It may be remarked, in passing, that these fumes were the chief cause of the complaints that were constantly brought out at Vallejo Junction a number of years ago. At about the same time (1906–7) there was brought into successful commercial operation a process designed for the precipitation of suspended particles of matter, either solids or liquids, by means of electricity. The process is known as the "Cottrell electrical precipitation process."

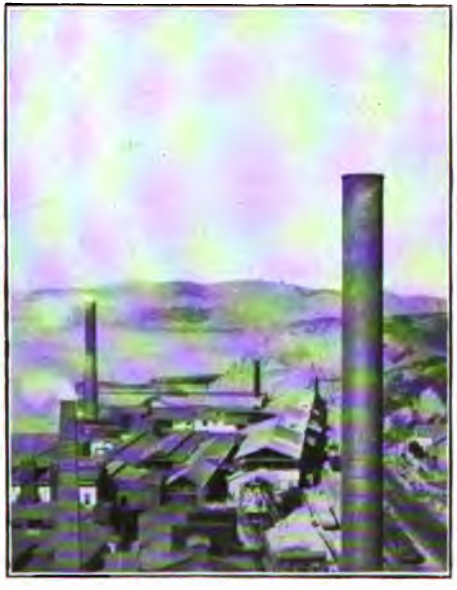
It was found experimentally that the Cottrell process effectually precipitated these fumes, and the installation of a plant sufficient in

[a] See A. E. Wells's report on "Conditions in and around the Selby smelter and the Selby 'smoke zone,'" pp. 63–81.

GENERAL APPEARANCE OF SELBY SMELTER PRIOR TO 1908.

A. BLAST-FURNACE STACK BEFORE INSTALLATION OF BAG HOUSE.

B. BLAST-FURNACE STACK AFTER INSTALLATION OF BAG HOUSE.



C. STACKS OF SELBY SMELTER AFTER CHANGES TO PLANT IN 1908.

size to handle all of them completely eliminated this element from the visible smoke issuing from the plant. This installation was in working order at about the same time the bag house was placed in operation.

Plate III, *A*, and Plate III, *B*, illustrate the appearance of the "parting-retort" stack before and after the installation of the Cottrell process.

Plate IV, *A*, shows a general view of the smelter stacks at the time the commission was organized.

ROASTER SMOKE.

There remained at the plant a single stack from which visible smoke issued. This was known as the "roaster stack." The smoke emanating from this stack resulted from the metallurgical processes known as "roasting," and owing to the type of furnace used contained, aside from its gaseous constitutents and the dust and fumes derived from metals, comparatively large amounts of fume of sulphuric acid which was generated during the roasting. In contrast with the smoke derived from the blast furnaces the smoke of the roaster stack was extremely difficult to clear of its visible element. The blast-furnace smoke contains only traces of sulphuric acid fume, which, although it does have an appreciable effect on the fiber of the bags through which the smoke filters in its clearing process, does not by any means prohibit the use of bags for this purpose. The roaster smoke generated by the type of furnace then in use contained such large quantities of sulphuric acid fume that it quickly destroyed the bags through which it was passed in an attempt to clear it. It was therefore impracticable, not to say impossible, to clear the roaster-stack smoke of its visible element in this way. In an effort to find a method for the elimination of the visible element of the roaster-stack smoke the smelter company experimented for some 18 months in an endeavor to adapt the Cottrell process to this purpose. After nearly $20,000 had been expended in this work the attempt was abandoned.

About this time an improved roasting furnace, known as the Dwight & Lloyd sintering machine, was given to the smelting industry. One of these machines was installed at the plant as an experiment, and the necessary changes were made in the metallurgical processes of the plant to permit its use. The use of this machine required a preroasting of the ores received at the plant, which contained large amounts of sulphur. Arrangements were made by the Selby Smelting & Lead Co. with an acid-making plant to receive and preroast these high-sulphur ores (California sulphurets) and then deliver them to the smelter. The new machine and new plan of

handling the ore worked well, and gradually, as the plant could be remodeled to accommodate them, additional Dwight & Lloyd machines have been installed and the old-type roasters (Ropp roaster) have been taken out. The Dwight & Lloyd machine, although it performed much the same office as the Ropp roaster, did not, on account of the different principles upon which its operation is based, produce sulphuric-acid fume to an extent anywhere near that of the older type of machine.

Upon assuming its work the commission found that the smelter was using two of these Dwight & Lloyd machines and one of the old-type (Ropp) roasters, with preparations being made for the installation of a third Dwight & Lloyd machine. It is necessary, therefore, to consider the composition of the smoke eliminated from the Selby smelter at the time the commission began its work—that is, May, 1913—and during the succeeding period up to May 15, 1914, when the commission finished its studies on the composition of the air of the smoke zone.

SUMMARY.

To summarize the conditions found by the commission when its work of investigation began, we note: First, the blast-furnace stack was giving off only invisible gases, the visible part of the smoke being removed by the blast-furnace bag house; second, the parting-retort stack (that to which the heavy sulphuric-acid fume is conducted) was giving off only invisible gases, all of the visible part being removed by the Cottrell electrical precipitation process; and, third, the roaster stack was giving off visible smoke.

As is made clear in the report of A. E. Wells in his detailed discussion of the metallurgical processes of the plant,[a] the invisible gases given off by the blast furnace are made up of the gases of the atmosphere together with carbon monoxide, carbon dioxide, a relatively small amount of sulphur dioxide, and a much smaller amount of the fume of sulphuric acid. During the course of its travels through the flue system most of the sulphuric-acid fume originating in the blast furnace combines with the metal constituents of the smoke to form solid compounds which, together with the other solids, are eliminated by filtration through the bags.

The invisible gases, therefore, that escape through the blast-furnace stack into the atmosphere are water vapor, nitrogen, oxygen, carbon monoxide, carbon dioxide, and a small amount of sulphur dioxide—less than 0.04 per cent by volume. Of these escaping gases the sulphur dioxide is the only one that is of any significance in relation to its liability to injure plants or animals or constitute a nuisance to man. In the small amounts in which it occurs in this

[a] "Conditions in and about the Selby smelter and the Selby 'smoke zone,'" pp. 63-81.

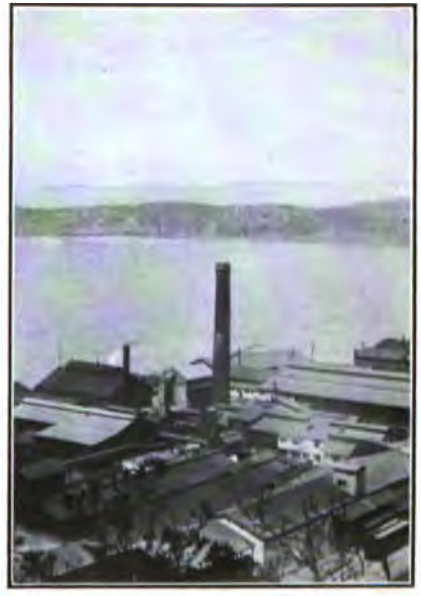
A. "PARTING-RETORT" STACK BEFORE INSTALLATION OF ELECTRICAL PRECIPITATION PROCESS.

B. "PARTING-RETORT" STACK AFTER INSTALLATION OF ELECTRICAL PRECIPITATION PROCESS.

A. GENERAL VIEW OF STACKS AT TIME COMMISSION WAS ORGANIZED.

1, blast-furnace stack; 2, parting-retort stack; 3, roaster stack.

B. ROASTER GASES LEAVING SMELTER UNFILTERED.



C. ROASTER STACK AFTER GASES WERE FILTERED.

particular case it has practically no influence on the main source of nuisance, if such is maintained by the smelter, in the area in question. The invisible gases from the blast-furnace stack can therefore be dismissed as a factor that contributes to the violation of the injunction decree.

The invisible gases coming from the parting-retort stack are practically nil. The efficiency of the Cottrell-process apparatus, which amounts to 99.5 per cent, eliminates any source of nuisance or injury from the parting-retort stack, in so far as the smoke zone is concerned. All of the sulphuric-acid fume coming from the parting retorts is passed through the Cottrell-process apparatus and is condensed to liquid sulphuric acid.

The one remaining source of atmospheric pollution is the roaster stack. Aside from the visible part of the smoke furnished by the roasting process, large amounts of sulphur dioxide are evolved. Except for the atmospheric air, which constitutes 98 per cent of the volume of the smoke, this sulphur dioxide is the principal part of the invisible part of the smoke produced by the roasting of ores at the Selby smelter.

CLEARING OF ROASTER-STACK SMOKE.

The amount of dust and fume produced in the roasting process under the conditions of operation obtaining when the commission began its work was about 5,000 pounds per day of 24 hours, whereas the amount of sulphur dioxide eliminated was in the neighborhood of 60 tons per day of 24 hours (equivalent to 30 tons of sulphur); whereas the maximum quantity of sulphur dioxide that could possibly be eliminated by the smelter was 90 tons per 24-hour day.

The commission early came to the conclusion that the smelter company should make an attempt to eliminate the visible portion of the roaster-stack smoke, as a result of which the following correspondence passed between the commission and the Selby Smelting & Lead Co.

SAN FRANCISCO, *October 25, 1913.*

SELBY SMELTING & LEAD CO.,
San Francisco, Cal.

GENTLEMEN: In connection with the studies being made by the commission relative to conditions in Solano County, it is desired to study the composition of the atmosphere when it is mixed with smelter smoke which has been freed from fume.

With this end in view the commission recommends that you install at the smelter and put into operation at the earliest possible date:

1. A bag house or an electrical precipitation plant for the removal of the suspended matter from the gases coming from the sintering machines.
2. An electrical precipitation plant for the removal of the sulphuric-acid vapor and suspended matter in the gases coming from the Ropp roaster.

Respectfully,

(Signed) RALPH A. GOULD,
Secretary.

SAN FRANCISCO, *October 28, 1913.*

SELBY SMELTER COMMISSION,
Monadnock Building, San Francisco, Cal.

GENTLEMEN: We beg to acknowledge receipt of your favor of the 25th instant, in regard to the desire of the commission to study atmospheric conditions in Solano County freed from fume, and in reply will say that at the earliest practical date we will endeavor to free our smoke from all fume, as desired by the commission.

Very respectfully,

(Signed) E. B. BRADEN,
Vice President, Selby Smelting & Lead Co.

After due consideration of the recommendation of the commission, the Selby Company decided upon the installation of a bag house for use in connection with the smoke from the Dwight & Lloyd sintering machines.

In March of 1914 the projected bag house was completed, and, after overcoming the numerous mechanical difficulties always encountered in the operation of installations of this kind, has been in successful operation, thereby clearing the roaster-stack smoke of its visible element. Since April, 1914, the smelter has given off no visible smoke, except during very short periods of time, when, for purposes of resetting the bags or overcoming some mechanical trouble, it has been necessary to allow the smoke to escape without passing it through the bag house.

Plates V, *A*, and IX, *B*, show the general appearance of the stacks of the smelter as they are at the present time (Nov. 5, 1914).

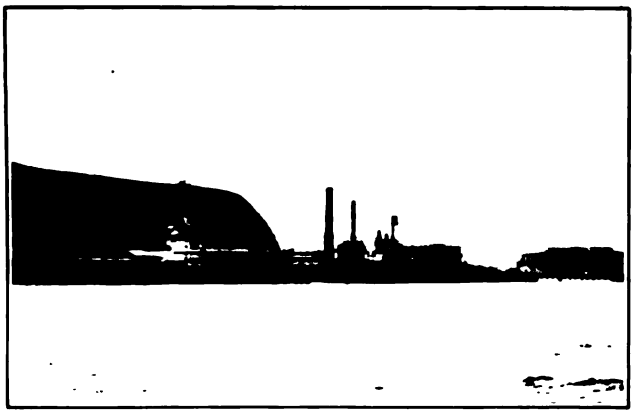
It must be borne in mind that the smelter company, although they still have one Ropp roaster installed, can not pass the smoke from it through this bag house. This Ropp roaster is used for a special purpose and only during the so-called open season. If the metallurgical practice of the plant requires the operation of this Ropp roaster at other times, apparatus of special design will be required to eliminate the visible part of the smoke from this furnace.

SULPHUR DIOXIDE AS A FACTOR IN THE MAINTENANCE OF A NUISANCE.

SULPHUR DIOXIDE OUTPUT OF THE SMELTER.

As a consequence of the elimination of the visible element of the smoke from the Selby plant, any injury or nuisance that may be created by or be due to the presence of compounds of lead, arsenic, or other metals, or to any other constituent of the visible element of the Selby smelter smoke is nil. The only nuisance or injury that can possibly be maintained or produced under the present régime of operations is that which may be due to the sulphur-dioxide gas that escapes from the roasting of the ores.

The question before the commission, therefore, is this—Does the sulphur dioxide at present being discharged from the stacks of the



A. GENERAL VIEW OF SELBY SMELTER, SEPTEMBER, 1914.

B. SAMPLING PLATFORM, ROASTER STACK.

C. OUTSIDE OF BLAST-FURNACE BAG HOUSE.

Selby smelter constitute a nuisance to the citizens of the region about Benicia, either by causing personal inconvenience or disagreeable experiences or by doing injury to crops, or to the soil of the area, or to domestic animals or other property of the residents of the smoke zone?

It should be remarked in passing, for the benefit of the layman, that when a given weight of ordinary sulphur burns in the air or in any medium in which sulphur dioxide is formed there is produced just double the weight of sulphur in the form of sulphur dioxide. Thus 1 ton of sulphur in burning forms 2 tons of sulphur dioxide; this 2 tons of gas occupies a volume of approximately 12,000 cubic feet at ordinary temperatures and pressures.

The metallurgical reports of the smelter show that during the "open season" immediately preceding the organization of the commission—that is, from November 15, 1912, to March 15, 1913—the average quantity of sulphur given off by the smelter was 29.3 tons per 24-hour day, or 58.6 tons of sulphur dioxide. The maximum amount of sulphur given off during any one day of this period was 43.2 tons, or 86.4 tons of sulphur dioxide, while the smallest amount eliminated was 11 tons of sulphur, or 22 tons of sulphur dioxide. This was during the season when the smelter could operate without regard to the terms of the injunction.

Although it was possible for the smelter to give off 90 tons of sulphur dioxide per 24-hour day during this period, the actual average output was only 65 per cent of the maximum possible amount. During the year in which the commission has been investigating the questions before it the roasting processes of the plant have been remodeled, until at the present time four Dwight & Lloyd sintering machines and one Ropp roaster constitute the roasting equipment of the smelter. The maximum quantity of sulphur dioxide which can be eliminated from this equipment through the roaster stack is 120 tons per 24-hour day. The influence of this increased possible output of sulphur dioxide on the maintenance of a nuisance in the smoke zone will be discussed later.

The smelter's average daily output of sulphur for each month of the years 1910 to 1913, inclusive, and the first four months of 1914 is shown by the vertical lines in figure 1. For example, the average daily output for the month of January, 1910, was 21.5 tons; for December, 1910, 31.5 tons, the minimum and maximum, respectively, for the year.

The connected circles show the output based on the daily averages for each year. It will be seen that the average daily output for the years 1910 to 1913, inclusive, and the first four months of 1914 was, respectively, 24.8, 25.4, 26.6, 24.4, and 28.3 tons. This is a small

output of sulphur compared with the enormous quantities emitted by many smelting plants.

It may be noted in passing, for the benefit of the layman, that the figures that show the amount of sulphur dioxide emitted from the smelter are calculated from the daily metallurgical reports of the smelter. These records are kept by the smelter to check the operation of the metallurgical processes. To the metallurgist they speak

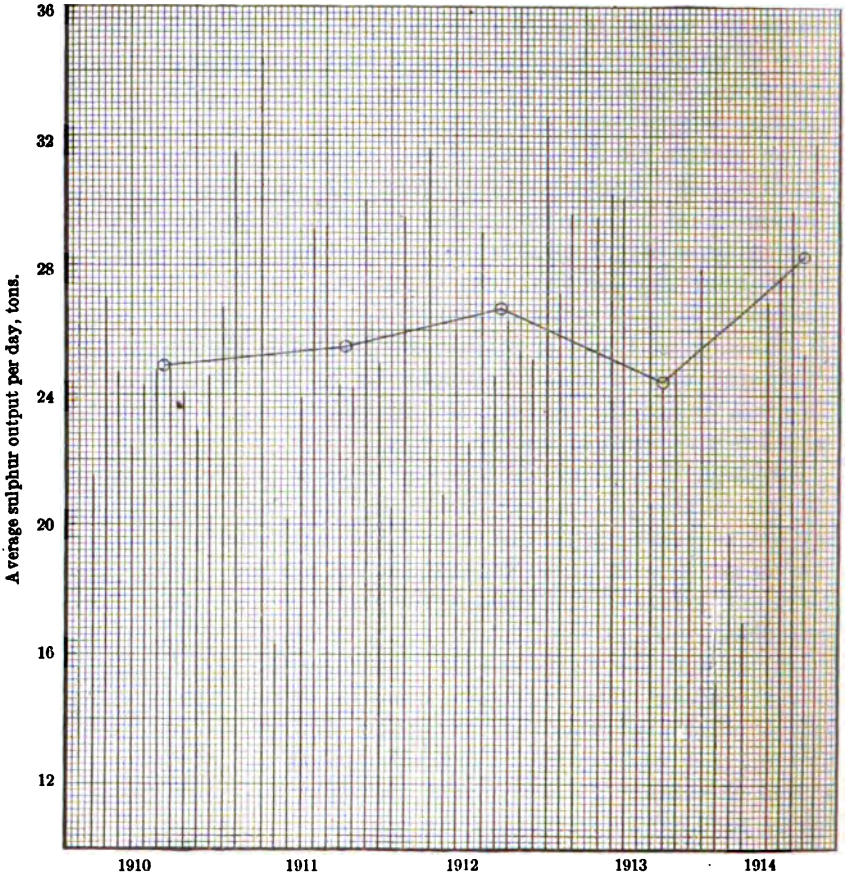


FIGURE 1.—Curve showing average monthly output of sulphur from the Selby smelter, 1910 to 1914. The heavy vertical lines represent sulphur output by months, the line farthest to the left representing the output for January.

a language of dollars and cents in the profitable operation of the plant. It may be contended that these metallurgical reports are not of value in the above connection because of a fancied belief that they can be manipulated to show anything the smelter company desires. This is not a fact. One obvious reason why these reports have not been tampered with or altered to suit the purposes of the smelter company is that until the organization of the commission

these reports have never been introduced as evidence in any of the litigation, and probably the smelter company entertained no expectation whatever that they would be so used. The figures representing the amount of sulphur dioxide emitted have been calculated from data that, as they stand on the metallurgical reports, are collected by the smelter for an entirely different purpose than that to which they have been put by the commission.

The graphic representation of the monthly sulphur output (fig. 1) shows that during the months of October, November, and December of 1913 the output of sulphur dioxide was very low. This low output was at the express request of the commission for the purpose of study during the end of the closed season and the beginning of the open season covered by the injunction.

FACTORS CAUSING DISTRIBUTION OF SULPHUR DIOXIDE IN THE ATMOSPHERE.

It may be contended that even though there was more sulphur dioxide emitted by the smelter during 1913 than in preceding years, it was not carried over the smoke zone because of the different wind directions and conditions of calm that existed in the area during that time as compared with the preceding years, and hence that the smoke was less noticeable. Such a contention, however, can not be maintained, for a study of the graphic representation of the wind conditions for the years 1911, 1912, and 1913 (figs. 2, 3, and 4) shows a striking similarity in these conditions during the three-year period covered.

The lines on these wind charts represent the percentage of time in each month during which the wind blew from the direction indicated. Although the names of the months are not given in the figures, the months are arranged to be read from left to right when facing the direction from which the wind blows. For example, during January, 1911, the wind blew, beginning with north and continuing around the compass, 0, 1.1, 32.7, 1.1, 7.5, 26.3, 4.3, and 0 per cent from the direction indicated. It was calm 27.4 per cent of the time.

During 1911 the wind blew from the southwest 54 per cent of the time, during 1912 there was southwest wind during 50 per cent of the time, and during the first nine months of 1913 the southwest wind blew 52 per cent of the time. During the same periods there was calm for 15 per cent, 16 per cent, and 11 per cent of the time, respectively, and the west wind blew 12 per cent, 12 per cent, and 20 per cent of and the time during 1911, 1912, the first nine months of 1913, respectively. In like manner the prevalence of wind from other quarters is in extremely close agreement.

Although these wind records have been collected by the smelter company and the commission has no means of absolutely checking

them, it is believed that they are accurate and reliable inasmuch as they make out a worse case against the smelter company than they would had it been the company's desire to manipulate the data. It should be remarked that such wind directions and observations as have been made by the commission's staff of observers check with the records taken by the smelter company during the course of the field work of the commission. Contention, if it is advanced, that differences in wind direction may account for any greater prevalence of

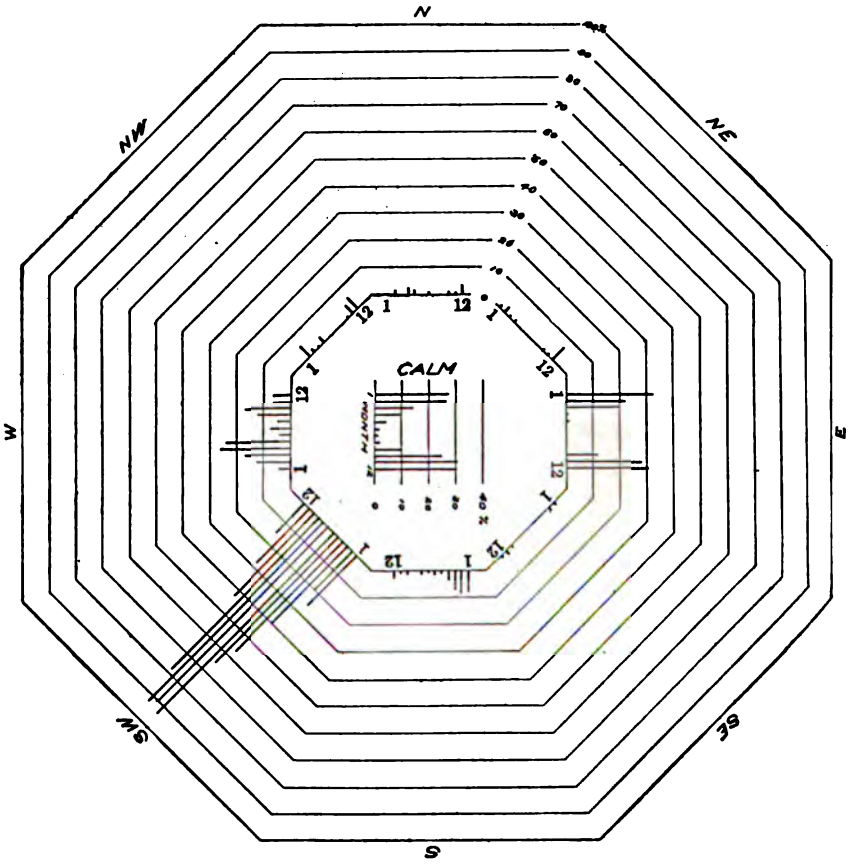


FIGURE 2.—Chart showing wind conditions in 1911.

sulphur dioxide in the atmosphere of the smoke zone in the years preceding 1913 can not, therefore, be maintained. The wind directions have continued to be the same in general and the amount of wind has been approximately the same during the three yearly periods.

Owing to the natural outline presented by the hills in the area and the hills on the Contra Costa County side of Carquinez Straits, there is formed a channel which plays an important part in the distribution and dissemination of the smoke from the Selby smelter. The prin-

cipal effect of this natural draw is to increase the movement of the smoke during periods of calm or very light winds from the west and southwest and perhaps to carry the smoke farther during periods of moderate or strong winds from these directions. During calms, smoke may drift over the area at any time, but with winds from any other direction than between south and northwest it is obviously impossible for the smelter smoke to pass over the smoke zone.

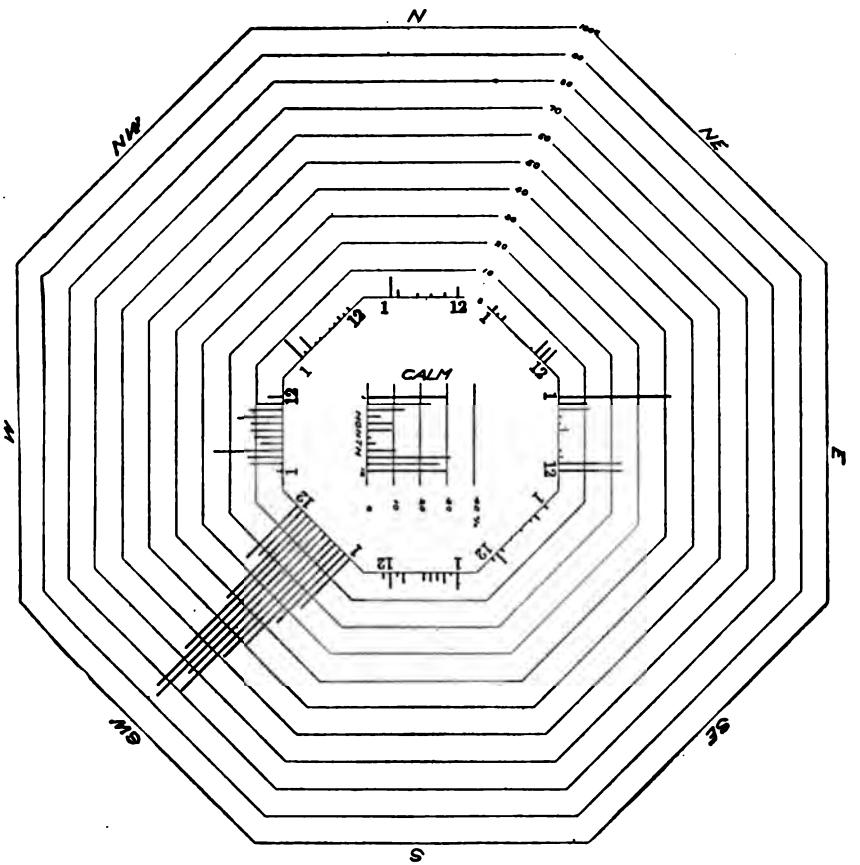


FIGURE 3.—Chart showing wind conditions in 1912.

It is obvious to all persons that, when the wind blows from the smoke zone toward the Selby smelter, the smoke can not be present in the smoke zone. It is just as obvious that when the wind blows from the smelter directly toward the smoke zone, then the smoke from the smelter may be present in the smoke zone. A line drawn from the smelter through the central portion of the smoke zone takes a general northeasterly course, so that any wind blowing from the south or from any point between south and northwest would be liable to carry the smoke into some part of the smoke zone. Plates VI, VII, and XXXVIII showing the Selby smoke zone illustrate this point.

SULPHUR DIOXIDE CONTENT OF THE ATMOSPHERE OF THE SMOKE ZONE.

GENERAL CONSIDERATIONS.

A study of the detailed notes taken by Mr. Dutton while interviewing the residents of the smoke zone inevitably gives one the impression that the smelter has been given a fairly clean bill of health by the very people who made the complaint that the injunction is

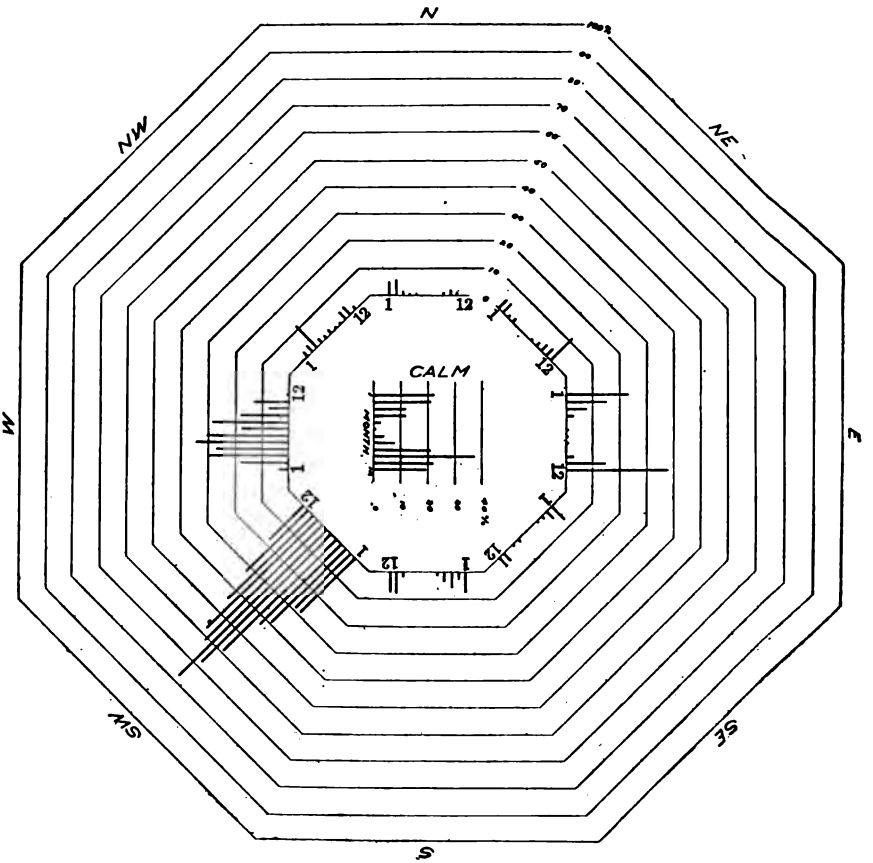
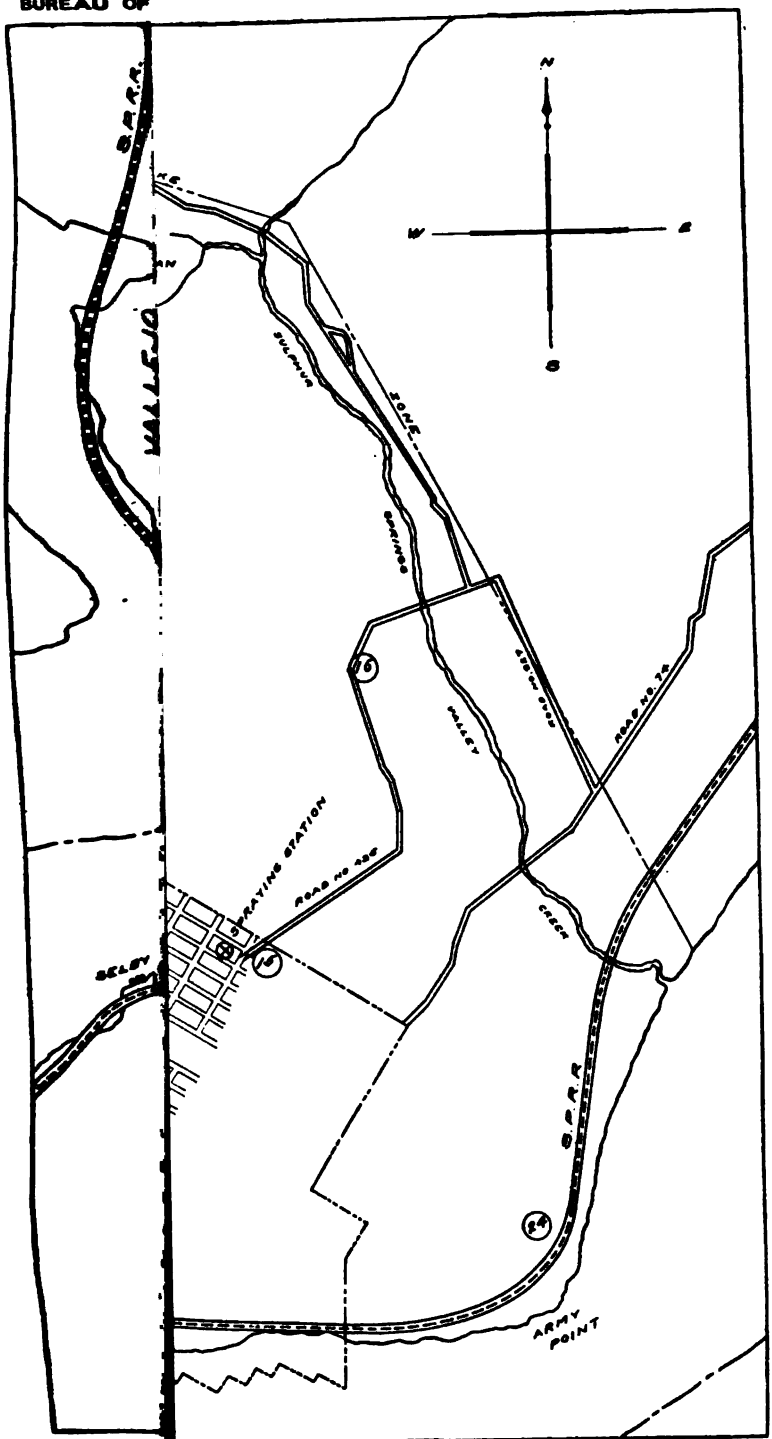


FIGURE 4.—Chart showing wind conditions in 1913.

being violated. It would be obviously improper, however, to base such a conclusion upon these statements alone. The incorrectness of many of the statements of residents of the smoke zone as to certain conditions being caused by "smelter smoke" must be evident to any person of even a small amount of knowledge of the processes carried on by the smelter and the properties of the constituent parts of smelter smoke. Certain statements are highly ludicrous and improbable, not to say impossible. It is also shown from the investigations of Mr. Dutton that statements of certain people of the smoke zone to the



S FOR TAKING AIR SAMPLES.

effect that conditions are better than they were can not be taken as proof that conditions actually are better.

It transpires as a result of the investigations of the commission that the amount of sulphur dioxide that has been discharged from the smelter has gradually increased, year by year. It will be noted that during the first nine months of 1913, which nearly every one states has been the best year in the matter of freedom from smoke trouble, 10 per cent more sulphur dioxide was emitted from the smelter stacks than in the year 1910, when, according to the testimony of most of the residents, the nuisance was very great, and constituted a serious menace to the community. While the fact that many of the residents of the smoke zone have stated that 1913 has been the best year for several years does not prove that the smelter is not violating the injunction, these statements do point to the fact that the "smelter-smoke smell," which is one of the factors contributing to the nuisance, has in the minds of many abated to a large extent.

The commission has considered that one of the most important phases, if not the most important, of its work was to determine the composition of the atmosphere of the smoke zone as concerns sulphur dioxide. It was evident that this investigation would occupy some considerable time and the services of several chemists. After a considerable search throughout the United States for a man of proper qualifications, the commission selected Mr. A. E. Wells, of Salt Lake City, and tendered him the post of metallurgist and chemist to the commission, in charge of field and laboratory work. Mr. Wells is a graduate of the Massachusetts Institute of Technology and has had extended experience in metallurgical operations and smelter-smoke investigations. The commission feels itself very fortunate in having procured Mr. Wells's services and desires to state that much of the excellence of the many reports submitted to the commission is due to his keen grasp of the conditions and his recognition of the desires of the commission for a complete investigation of them.

The investigations conducted by Mr. Wells, under the immediate supervision of the commission, to determine the composition of the atmosphere of the smoke zone have been very extensive. So far as can be found by a careful search of the literature, the commission's work has been much more extensive and exhaustive than any heretofore attempted. In collecting such an immense amount of information the commission has been guided by a desire to know fully and absolutely the conditions at all times within the smoke zone. The period of investigation extended from September 17, 1913, to December 15, 1913, and from March 1, 1914, to May 15, 1914. There were engaged upon the work, aside from Mr. Wells, under whose direct superintendence it was prosecuted, eight chemists and six helpers.

During the entire course of the investigation especial attention was given to the metallurgical processes going on at the smelter, and the

amount of sulphur dioxide eliminated from the smelter during the tests in the smoke zone has been checked by the staff of the commission. Determinations were made when the wind conditions were the worst possible for the area and when the output of sulphur dioxide from the smelter was, by request of the commission, at a maximum. Other tests have been made when the smelter was entirely closed down with the wind conditions favorable and unfavorable to the smoke zone. Every attempt has been made to obtain these data under all possible conditions in order that maximum, average, and minimum figures might be obtained as to the sulphur dioxide content of the atmosphere of the smoke zone. That this has been accomplished is shown by the numerous figures which are given in Mr. Wells's report.

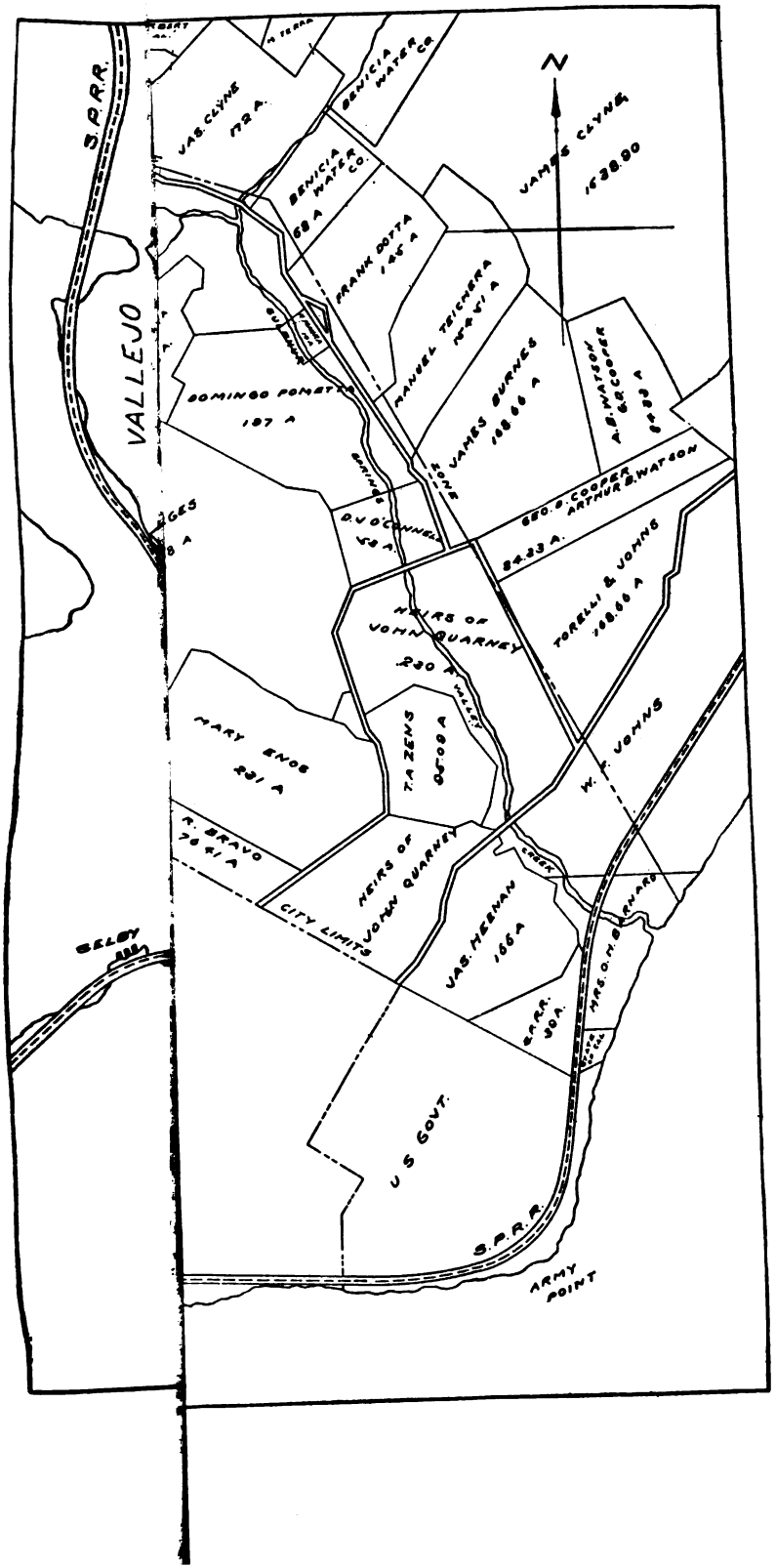
The collected data have been taken at all times of the day, except between the hours of 8 p. m. and 4 a. m. For the reason that the determination of sulphur dioxide depends upon the comparison of two colored solutions, work at night was not practicable. Some of the residents of the smoke zone made an especial point of the difference between the air at night and during the day, but observations of the wind directions during the night showed no more unfavorable winds at that time than during the early morning hours, and these latter are covered by the data collected. It was, therefore, obvious to the commission that little would be gained by taking samples at night.

METHODS OF DETERMINING SULPHUR DIOXIDE.

A careful review of the literature of "smelter smoke" failed to disclose any methods for determining sulphur dioxide which, in the opinion of the commission and its staff, would satisfy the requirements of the proposed investigations. It was found necessary, therefore, to develop a method of analysis that would fulfill the desired requirements, namely, instantaneous sampling, continuous or average sampling, a high degree of accuracy and rapidity of execution combined with ease in field manipulation. By combining the best points gathered from the literature with the experience of various persons who had engaged in similar work, a method for the determination of sulphur dioxide in the atmosphere was eventually evolved which answers all of these requirements. It is believed that the method finally adopted is by far the best yet used in work of this character, and that the results obtained are accurate and representative of the conditions which exist in the smoke zone in relation to sulphur dioxide.

ANALYTICAL RESULTS.

Two permanent observation stations, known as station 1 and station 2, were established in the smoke zone and chemists were placed in charge of them. These stations were selected so as to obtain, in so far as possible, the maximum amounts of smoke, in its most con-


S.P.R.R.
VALLEJO
JAS. CLYNE
172 A.
BENICIA WATER CO.
BENICIA WATER CO.
68 A
FRANK DOTTA
145 A
JAMES CLYNE
1538.90
N
MANUEL TEICHERA
JAMES BURNES
168.66 A
A.B. WATSON
G.D. COOPER
DOMINGO POMETTA
197 A
D.J. O'CONNELL
GEO. D. COOPER
ARTHUR B. WATSON
84.33 A.
TORELLI & JOHNS
168.66 A
HEIRS OF
JOHN QUARNEY
230 A
MARY ENOS
231 A
T.A. ZENS
W. F. JOHNS
R. BRAVO
76.41 A
HEIRS OF
JOHN QUARNEY
CITY LIMITS
JAS. HEENAN
166 A
MRS. O.H. BARNARD
S.P.R.R.
U S GOVT.
S.P.R.R.
ARMY
POINT
SELBY

centrated form, which blew over the smoke zone. The location of the stations [a] was chosen after a consideration of data collected in various parts of the smoke zone prior to their establishment. These data were collected by means of an automobile laboratory, which was equipped for three purposes—first, to collect the data mentioned above; second, to collect data in various sections of the smoke zone simultaneously with those collected at the permanent stations; and, third, to collect data in various places contiguous to San Francisco Bay, subjected and not subjected to contamination by smelter smoke.

During the time between September 15, 1913, and May 15, 1914, a total of 4,862 observations or determinations of the sulphur dioxide content of the atmosphere of the smoke zone have been made under every condition which could, in the opinion of the commission and its staff, have any bearing upon the existence of a nuisance from the smoke of the Selby smelter anywhere within the smoke zone. Their distribution as to the direction of the wind is shown in the following table, together with the maximum, minimum, and average amounts of sulphur dioxide found.

The table gives a summary of the results of the 4,862 determinations made at the two permanent stations and with the movable automobile laboratory.

The maximum value of 7.1 parts per million was obtained at station 2, which, it will be noted, was situated on the high hills, 2½ miles from the smelter, at a time when a gentle breeze from the west was carrying the smoke stream from the smelter directly to this spot, and while the smelter, at the request of the commission, was sending out smoke at its maximum capacity. The legend <0.2 is to be read less than 0.2 part per million, or quantities too small to be determined by the analytical methods used.

Results of determinations of SO_2 content in atmosphere of smoke zone of Selby smelter.

Direction and force of wind.	Number of determinations.	SO_2 parts per million, by volume.		
		Maximum.	Minimum.	Average.
Blowing from smelter toward smoke zone.				
Slight west wind	1,114	7.10	<0.20	0.44
Moderate or strong west wind	1,252	1.25	< .20	.27
South or southwest wind	683	1.00	< .20	< .20
West or northwest wind	257	.60	< .20	< .20
Total	3,306	.....	.....	.28
Blowing from smoke zone toward smelter.				
East or southeast wind	714	.80	< .20	< .20
North or northeast wind	317	.40	< .20	< .20
Northwest wind	525	.60	< .20	< .20
Total	1,556	.....	.....	< .20
Grand total	4,862	[b] 7.10	[a] < .20	.22

[a] The positions of these stations are shown on the map comprising Plate XXXVIII.
[b] Maximum.

As addendum to this table it may be noted that of the 2,841 determinations made during a period of eight months within the limits of the city of Benicia no one showed a sulphur dioxide concentration as high as 2.5 parts per million, while of the 4,862 made in the whole smoke zone only 6 showed a concentration higher than 3 parts per million. These results are significant when attention is called to the fact that it is impossible to detect by the sense of smell sulphur dioxide when it is present in the atmosphere in a concentration below 3 parts per million.

DISCUSSION OF RESULTS.

It is impossible to discuss the data concerning the sulphur dioxide content of the atmosphere of the smoke zone and other places with any degree of fullness without going into innumerable details. It is not strictly accurate, for example, to hold average data as representative nor to assume that positive conclusions can be drawn from them. The mass of detail that must necessarily be considered in drawing conclusions would be most tiresome to the layman if he attempted to follow it, and it has been considered by the commission advisable for the purposes of this report not to go into such a detailed discussion here, but leave that, for those who are interested, to the detailed report. In the discussion that follows, therefore, those figures that are quoted will be such as are, in the opinion of the commission, the proper ones for a simple and correct exposition of the question. It is the aim of the commission to base its findings upon actual facts scientifically collected and determined, but to discuss these findings and the collected data in nontechnical terms and in such a way as to be easily followed by the layman.

A study of the detailed notes in connection with the observations made during the existence of slight west winds—that is, when the smoke is gently drifting in practically its full volume over the area—discloses that 21 determinations were made in the area that showed more than 2 parts SO_2 per million parts of air.[a] This represents 1.8 per cent of the total observations taken during the worst wind conditions for the smoke zone. Further study of the detailed notes shows that these 21 determinations average 3.6 parts SO_2 per million parts of air, including one single determination that was as high as 7.1 parts SO_2 per million parts of air. The data show that these 21 determinations represent the presence of more than 2 parts SO_2 per million parts of air for a total of 220 minutes, or 3 hours and 40 minutes, during an elapsed time of eight months.

In the light of the investigations carried on to determine the sensitiveness of the average person to sulphur dioxide, it does not

[a] In the discussion of the concentration of sulphur dioxide in the atmosphere and elsewhere, the chemical symbol for sulphur dioxide is frequently used, thus, SO_2.

appear that sulphur dioxide in the concentration mentioned above, for the small proportion of time in which it could possibly have been present in the atmosphere would constitute a serious inconvenience or menace to the health of any community, for it was established in the experiments above referred to that the average person could not even detect the presence of any foreign substance in the atmosphere when the amount of sulphur dioxide was below 3 parts per million of air and that such a concentration was not considered a nuisance by a single one of the 60 subjects experimented upon.

If we assume for purposes of discussion that every resident of the smoke zone is sensitive to the odor of sulphur dioxide to a degree double that of the average person, and if we further assume that such persons can detect and even consider as a nuisance an atmosphere containing 2 parts SO_2 per million, then the smoke zone could have been subjected to such a nuisance from the Selby smelter smoke during 0.06 per cent of the time from September 15, 1913, to May 15, 1914. This means that had the smoke appeared with perfect regularity and had a slight west wind prevailed during the entire time, the smoke would have been smelled and have been a nuisance to the entire population of the smoke zone for 4.5 minutes in every 24 hours from September 15, 1913, to May 15, 1914. This puts the case in its most exaggerated form and is based on the assumptions that the residents of the smoke zone are able to detect 2 parts of SO_2 in a million parts of air and that the wind is continuously blowing gently from the west.

Under the actual conditions, when a concentration of 3 parts of SO_2 per million parts of air or more existed, the smoke would have been objectionable for a period of 44 minutes during the eight months.

As a matter of fact, the average person can not even detect—much less consider a nuisance—the presence of sulphur dioxide in the atmosphere when the concentration is below 3 parts per million, and the wind records taken by the field staff during this period show that light west winds blew less than 20 per cent of the time. It therefore follows that the attentive person would be aware of the presence of sulphur dioxide in the atmosphere of the smoke zone during 16 seconds of time each day, or for a total period of 65 minutes in the eight months during which the investigations of the commission were in progress.

These conclusions based on the mean concentration of sulphur dioxide in the atmosphere of the smoke zone show that it is impossible to conclude that the Selby smelter is maintaining a nuisance by emitting sulphur dioxide into the atmosphere in such quantity as to produce a disagreeable or objectionable odor or to disagreeably or injuriously affect the throat or lungs of human beings or domestic animals living within the smoke zone.

The commission is of course cognizant of a certain weakness in a method of arriving at conclusions based on the average content of sulphur dioxide in the atmosphere of the smoke zone, for it is well known that the instances of smelter smoke damage are the result of bathing the growing vegetation, ordinarily for short periods of time, with streams or puffs of smoke of high sulphur dioxide content direct from the smelter stacks. It therefore follows that the maximum concentrations of sulphur dioxide found by the commission's staff in the smoke zone must receive due consideration.

The investigations of Mr. Wells and his staff of chemists show six occasions when the atmosphere around station 2 contained over 3 parts SO_2 per million, and of these a single one reached 7.1 parts of SO_2 per million. Within the city of Benicia itself no one of 2,841 determinations showed a concentration as high as 2.5 parts per million, whereas over 99 per cent showed less than 1 part per million.

If under these circumstances the prevailing concentrations produce so small a degree of nuisance, it is certain that there would exist no nuisance caused by the odor of the smoke when considered on the basis of the determined facts relative to the sensitiveness of man to sulphur dioxide.

It may be contended that if the concentration was found at one time to be as high as 7.1 parts of SO_2 per million parts of air, the same condition would recur many times during the so-called "closed season," due to the smelter company designedly increasing its capacity and in consequence its output of sulphur dioxide.

As a matter of fact, this high concentration was found under the most adverse wind conditions and with nearly a maximum output of sulphur dioxide from the plant (80 tons per 24 hours). The maximum concentration found in the city limits of Benicia was 2.4 parts of SO_2 per million parts of air, an amount below the limit of the sense of smell of the average person. During any other wind conditions than those of light west winds the concentration of sulphur dioxide in the atmosphere of the smoke zone did not exceed 1.25 parts per million parts of air. This is a point at which even the supposed supersensitive inhabitants of the smoke zone could not detect its presence.

In the light of the data collected by the commission the probability of the recurrence of 7.1 parts of SO_2 per million parts of air in the atmosphere of the smoke zone would be as 1 is to 4456, if the smelter ran at its maximum capacity during the entire season. It is extremely improbable that such a condition would ever exist, and it would appear that the possibility of a recurrence of 7.1 parts SO_2 per million parts of air could be dismissed from any consideration in so far as the odor from the smoke is concerned. The conditions that actually do exist at the present time, and have existed during the investigations of the commission, have been accurately determined.

In the opinion of the commission the average content of sulphur dioxide in the atmosphere of the smoke zone is so low as to preclude the possibility of the existence of a continuous nuisance, which would manifest itself by an objectionable odor or by its effect upon the throat and lungs of human beings or of domestic animals. The commission is of the opinion that the occasional higher concentrations of sulphur dioxide which occur in the atmosphere of the smoke zone are so few in number and so low in sulphur dioxide that no nuisance other than a rapidly transient one is caused by them, which manifests itself by an objectionable odor or by its effect upon the mucous membrane linings of the throat and lungs of human beings or of domestic animals.

There have been 21 occasions, none of which endured for more than 25 minutes, all of which in the aggregate lasted only 250 minutes, during the period of the field tests when extraordinarily sensitive persons could have smelled the smoke from the Selby smelter, and thereby could have been subjected to a nuisance. At the worst this means that the nuisance would have been endured for one 25-minute period in every seven days during this time. Otherwise interpreted, it means that had the visitations been of uniform duration, the odor could not have persisted for more than 12 minutes once in every seven days. The commission is of the opinion that this does not constitute a nuisance within any reasonable construction which can be placed upon the meaning of the word as ordinarily used or as used in the injunction decree or in the stipulation.

Of the remaining 3,748 determinations made in the smoke zone, no figures were obtained higher than 1.25 parts SO_2 per million parts of air. This, as before noted, is below the limit of sensitiveness of the supposed supersensitive residents of the smoke zone, and is so low that none of the 60 subjects of the experiments, before referred to, could detect the presence of anything abnormal in the atmosphere breathed by them. It must be assumed then that this amount is below the limit of sensitiveness of man. As a consequence, such an amount could not be productive of a nuisance through its odor or through its effect on the throat and lungs.

THE OCCURRENCE OF SULPHUR DIOXIDE IN OTHER PLACES.

In order that the commission might be able to draw proper conclusions from the data relating to the composition of the atmosphere of the smoke zone, it was found necessary to collect data in atmospheres that are not contaminated by smelter smoke, but do contain determinable quantities of sulphur dioxide. For this purpose the automobile laboratory was used. Data were collected showing the

content of sulphur dioxide in the atmosphere of San Francisco, Oakland, Berkeley, Richmond, San Pablo, Tormey, Crockett, Martinez, and Avon. The two last-named places are in the area over which smoke from the Mountain Copper Co. smelter, at Suisun Point, blows at certain times. Tormey and Crockett are within the area sometimes covered by the Selby smelter smoke in Contra Costa County.

As will be seen from the figures obtained in San Francisco, Oakland, and Berkeley,[a] sulphur dioxide exists in atmospheres which are not contaminated by smelter smoke, there being no smelters or works of similar character in either of the three places. The source of this sulphur dioxide is the various manufacturing plants in the cities mentioned. It originates in the sulphur that exists in the fuel used. Both coal and oil contain considerable sulphur, which in the burning of the fuel is changed to sulphur dioxide and is given off with the smoke created. A few industries generate additional amounts of sulphur dioxide in the region named.

The composition of the atmosphere in and around Richmond and San Pablo is influenced by the smoke discharged from the oil refinery of the Standard Oil Co. which is situated at Point Richmond. No investigations have been made by the commission as to the quantity of sulphur dioxide eliminated by this plant, but the sulphur dioxide content of the atmosphere of these places was desired and obtained for purposes of comparison.

Comparing the sulphur dioxide content of the Selby smoke zone with that found in other localities around San Francisco Bay it is noted that the air along the ocean beach in San Francisco contains no measurable quantity of sulphur dioxide, whereas the air within the city, on calm mornings, reaches nearly 2 parts SO_2 per million parts of air. To be exact, 1.8 parts SO_2 per million parts of air was the highest amount found in the city in 173 determinations. The average of all the determinations made in San Francisco was 0.3 part SO_2 per million parts of air, which average is slightly higher than that found in the Selby smoke zone. It is to be noted, however, that the figures for San Francisco were not as extensive as for the smoke zone and while the average shows higher it does not necessarily mean that the actual average composition of the San Francisco air is higher in sulphur dioxide than the air of the smoke zone. It is probable that owing to the high winds prevalent in San Francisco during the late morning and early afternoon the industrial smoke which is constantly being given off in the city is much more widely disseminated than the Selby smoke so that the average of tests taken through the day would be less than those taken similarly in the smoke

[a] Report of A. E. Wells.

zone. It is quite within the bounds of possibility and indeed it is quite probable that when samples are taken under wind conditions that are properly comparable for the two areas, the average of the samples taken in San Francisco would be higher than those taken in the Selby smelter smoke zone, although the latter would probably show many more puffs or higher maximum figures than those taken in San Francisco. While the above is more or less speculative it is apparent from the data collected that the air of the smoke zone differs very slightly from that of the business and manufacturing center of San Francisco in its average content of sulphur dioxide.

The air of Oakland and Berkeley, owing to the less number of industrial plants and the influence of different wind conditions, contains on the average slightly less sulphur dioxide than that of the smoke zone or of San Francisco. The conditions are such that the average of the determinations more nearly represents the actual average conditions of the atmosphere than does the average of the determinations in either of the other areas. In these cities no amount above 1 part SO_2 per million parts of air was found in 148 determinations. The detailed tests show a closer agreement to the average of the results; but few determinations approaching the maximum figure obtained.

The determinations made in and about the city of Richmond and at San Pablo should properly be regarded as belonging to one area. The determinations made in Richmond, contiguous to the Standard Oil refinery, show an average of 1.10 parts of SO_2 per million parts of air. Segregating these tests into those made when the refinery smoke was in the vicinity of the sampling place and when the refinery smoke was not in the immediate vicinity shows for the first conditions an average of 1.95 parts SO_2 per million of air and for the second an average of 0.4 part SO_2 per million parts of air. These figures are much higher than the average for the smoke zone or for the other places considered. Even with an average of 0.4 part SO_2 per million of air, with conditions that made for many more puffs of higher concentration than was usually found in the smoke zone, there seems to be small or no complaint by residents of the area that the smoke from the refinery is considered a nuisance.

The sulphur dioxide content of the atmosphere of the country immediately surrounding the smelter at Suisun Point, in the neighborhood of Martinez, has also been studied. A series of 168 determinations was made when the wind direction was such as to blow the smoke from the smelter over the area. These figures show an average content of 0.23 part SO_2 per million parts of air, with a maximum for one test, of 1.7 parts SO_2 per million parts of air. It will be noted that this average is slightly higher than that in the Selby smoke zone, but the maximum concentration found is not nearly so high. For-

tunately for the smelter, situated at this point, the prevailing winds (these same winds also blow over the Selby smoke zone) blow the smoke from the plant over an extensive area of water, Suisun Bay, so that no urban community or agricultural area is affected by the smoke.

In general summary the comparison of the sulphur dioxide content of the atmosphere of the Selby smoke zone with the sulphur dioxide concentration of the atmosphere in other areas around San Francisco Bay and its tributary waters is highly favorable to the Selby smoke zone as to the average amount of sulphur dioxide present. The Selby smoke zone has, however, higher concentrations for short intervals than any of the other areas investigated. The other areas have a more constant higher concentration of sulphur dioxide in the atmosphere than the Selby smoke zone.

CONCLUSIONS.

A careful consideration of all of the data collected concerning the occurrence of sulphur dioxide in the atmosphere in the smoke zone and other places establishes the conclusion that the Selby smelter by the emission into the atmosphere of sulphur dioxide from its plant does not maintain a nuisance in the southern portion of Solano County, Cal., as referred to an objectionable odor or disturbing physiological effects upon the mucous membrane linings of the throat and lungs of human beings and domestic animals.

THE EFFECT OF SULPHUR DIOXIDE ON MAN.

In order to determine the extent to which the invisible part of the Selby smelter smoke may become a nuisance through the physiological effect its content of sulphur dioxide exerts upon man by disturbance of the normal functioning of the respiratory organs or disagreeably affecting the olfactory organs, the commission undertook an investigation to determine the sensitiveness of various persons to sulphur dioxide. It has already been shown that sulphur dioxide is the only gas discharged into the atmosphere through the stacks of the Selby smelter that has an odor or can possibly be present in sufficient amount to produce any effect upon the throat and lungs when it is diluted by the air into which the smoke is discharged.

In the conduct of this investigation [a] 60 subjects were experimented with. Some of the subjects were observed through more than one experiment, so that a total of 85 experiments were recorded. Thirty-two of the subjects were persons who were thoroughly familiar with the odor and general characteristics of sulphur dioxide, and 28 were only sufficiently familiar with the gas to be able to identify

[a] See "Tests to determine the sensibility of man to sulphur dioxide at high dilution," p. 169.

it as "like sulphur matches when they burn," or some similar method of comparison. Those thoroughly familiar with the gas were technically trained men or men who had worked in plants where sulphur dioxide is generated or is used; they were for the most part chemists, engineers, and smelter men. Those who were unfamiliar with the gas were the average intelligent citizens, sometimes capable of accurate description of the sensations they experienced under the tests and sometimes not; they knew the gas only as something which had a "sulphur smell."

Sulphur dioxide (SO_2) is a colorless gas of characteristic pungent odor and acid taste. It is 2.21 times heavier than air, but mixes readily with it in all proportions, and once mixed does not, contrary to popular belief, again separate. In its concentrated form it produces marked physiological disturbances in all animal and vegetable organisms with which it comes in contact. It dissolves to a limited extent in water and has the property of combining with oxygen under proper conditions to form sulphur trioxide (SO_3). Sulphur trioxide combines very readily with water to form sulphuric acid.

Of those subjects who were acquainted with the gas and were trained to observe and report their observations correctly, none could detect the presence of the gas when it was breathed in concentrations of 1 part SO_2 per million parts of air. When the concentration reached 2 parts SO_2 per million, 13 of these subjects suspected the presence of something foreign in the air being breathed but could not identify the substance, while 2 of the 32 thought they could identify the presence of the gas by their sense of taste, although they could not smell it. With 3 parts SO_2 per million in the atmosphere they were breathing 26 of the subjects identified an acid gas as being present, and 6 could detect nothing other than a foreign substance in the atmosphere. Of the 26 who could detect an acid gas, 21 identified it as sulphur dioxide with more or less positiveness, while 5 were doubtful of its identity. At 4 parts SO_2 per million parts of air all but 2 of the 32 subjects were able to detect and positively identify the gas as sulphur dioxide. The two exceptions were men who had become more or less immune to the action of the gas from working in smelters where the concentration is at times very high. At 5 parts SO_2 per million parts of air all subjects but 1, who was especially insensitive, were able to detect the gas. At 8 parts SO_2 per million all subjects, except the above mentioned one, could identify the gas as sulphur dioxide.

This would seem to indicate that persons who are thoroughly acquainted with the properties of sulphur dioxide, through study of or experience with the gas itself, can usually detect its presence in the atmosphere and identify the gas either by the sense of taste or smell when its concentration is about 4 parts per million or more.

Approximately three-fourths of such persons are able to detect and identify the gas when its concentration is 3 parts per million, while about 40 per cent are conscious that a foreign substance is in the atmosphere when the concentration is 2 parts SO_2 per million or more. In concentrations of less than 2 parts SO_2 per million, even persons thoroughly familiar with the properties of sulphur dioxide are unable to detect the presence of any foreign substance either by the sense of smell or the sense of taste.

Of those subjects who were unacquainted with the properties of sulphur dioxide and whose training, in so far as ability to observe and record their observations is concerned, had been that of the average person, none could detect anything in an atmosphere containing 1 part SO_2 per million parts of air. This agrees with the observations of the "trained" subjects. At a concentration of 2 parts SO_2 per million, 2 of these persons detected a foreign smell in the atmosphere they were breathing but could not describe it. With 3 parts of SO_2 per million, 4 subjects "smelled something," and 6 smelled "burning sulphur," while 18 "didn't smell anything." When the atmosphere contained 4 parts SO_2 per million, 10 of the "untrained" subjects smelled "burning sulphur"; 4 "smelled something," and 14 did not note any sensation different from that experienced in breathing the ordinary air. With a concentration of 5 parts SO_2 per million, all of the "untrained" subjects except 6 "smelled something" or "smelled burning sulphur." At 12 parts SO_2 per million, all of the subjects could identify the gas as that of burning sulphur.

This would would seem to indicate that the average citizen, not technically trained, can usually detect the presence of sulphur dioxide in the atmosphere and can identify it either by sense of taste or smell when its concentration is 5 parts SO_2 per million parts of air or more. One-half of such persons are able to detect the presence of the gas and some of them can identify it, when the atmosphere contains 4 parts SO_2 per million. When the atmosphere contains 3 parts SO_2 per million, 65 per cent of the average citizens fail to record any unusual sensations when breathing it, whereas only 217 persons in every thousand would experience the feeling of breathing an atmosphere contaminated with "smell of burning sulphur." When the concentration is 2 parts SO_2 per million, only the most sensitive, 71 in every thousand, can detect a foreign odor; and below that concentration none can detect any foreign odor whatever.

Consideration of the data from all points of view indicates that a proper conclusion will be drawn from this investigation if it is stated that the average citizen is conscious of pollution of the atmosphere by sulphur dioxide when its concentration is approximately 3.5 parts per million parts of air; and the "trained" person is conscious

of such pollution when the concentration is approximately 2.5 parts SO_2 per million parts of air.

In order to positively establish the minimum concentration of sulphur dioxide that would be considered a nuisance to all persons, it would be necessary to experiment with a much larger number of subjects. The time at the disposal of the commission did not permit of this. It was found as a result of the work done in this direction that the elements of psychology and personal idiosyncrasy entered into the matter to a great extent. The symptoms recorded by the various subjects, both "trained" and "untrained," were very dissimilar. No agreement was found between the ideas expressed as to what concentration was a nuisance. Without exception, however, all subjects considered that the point of concentration at which they could just detect a foreign substance or at which they were just conscious that there was something foreign in the atmosphere, was not a nuisance.

The commission is of the opinion, therefore, that in order that the smoke from the Selby smelter shall produce a nuisance in the smoke zone, sulphur dioxide must be discharged from the smelter in such an amount that as the smoke blows over the smoke zone the concentration of sulphur dioxide in the atmosphere of the smoke zone must be 3 parts per million or more. This figure is the mean of those recorded from the "trained" and "untrained" subjects, and refers solely to a nuisance brought about by the presence of a disagreeable or offensive odor.

The concentration of sulphur dioxide that is necessary for the production of injury to plants is a subject that can not be sharply delimited. This phase of the question will be discussed later.

THE EFFECT OF SULPHUR DIOXIDE ON GROWING BARLEY.

The commission is of the opinion that the word "nuisance," as used by the court in the injunction decree and in the stipulation under which the commission was brought into existence, embraces within its meaning any injury which may be done to growing crops or cultivated or forage plants.

Within the smoke zone the commission's investigations relative to the composition of the atmosphere have demonstrated the fact that sulphur dioxide in measurable amount is frequently present in the atmosphere of the smoke zone, and have also shown that the greater part of this sulphur dioxide is directly due to the smoke from the Selby smelter. Furthermore, it is well known that sulphur dioxide has the property of injuring plant growth under certain conditions.

Investigations recorded in the literature covering this subject show that the concentrations of sulphur dioxide required to do injury to

plants as stated by the individual investigators varies between 1 part SO_2 per million parts of air and 40 parts SO_2 per million parts of air. The concentrations required are dependent upon the kind of plant under experimentation, the method of fumigation, and many other conditions. A detailed discussion of these various conditions would lead to interminable lengths, and no generalized conclusion can be drawn from the work previously reported which can be set down in definitely delimiting figures. Comparatively few investigators have worked upon grain crops, although the various grains are known to be very sensitive to sulphur dioxide. As near as can be judged, these investigations show that a concentration of approximately 10 parts SO_2 per million parts of air is necessary to produce injury on growing grain.

Owing to the rather wide divergences in the conclusions of the various investigators and to the fact that in the Selby smoke zone, where a very low average content of sulphur dioxide exists in the atmosphere, distinct injury was noted to some of the most sensitive plants, it seemed essential that further data be collected to throw further light on the question of sulphur dioxide injury to plants growing in the area.

In the opinion of the commission one very grave error which appears in all of the experimental work of which the commission has any knowledge is the absence of conditions of fumigation that approach those existing when plants are fumigated by smelter smoke in the open field. Most, if not all, of the previous investigators make the fumigation by admitting to a closed container (cabinet or "smoke-house") definite quantities of sulphur dioxide. These quantities are so calculated as to produce the desired concentration in the air which fills the container when mixed with the air of the container by some mechanical means, such as a fan. Although this method no doubt produces the calculated mixture or concentration during the very first portion of the fumigation, it is evident that if the plants are injured by the sulphur dioxide through its absorption by the respiratory system of the plant (the method whereby injury is generally conceded to take place) the concentration of the sulphur dioxide is rapidly lowered as this absorption proceeds, to say nothing of the other influences present, such as soil and the walls of the container and the number of plants present, which are all active in reducing the concentration of the gas. Thus the plant is not subjected to a uniform concentration of sulphur dioxide during the fumigation.

Another serious error, which is the direct result of the method of fumigation described above, is that the number of fumigations to which the contents of the cabinet have been subjected, without regard to the length of time each fumigation has proceeded, or to the number

of plants contained in the cabinet, have been taken as measuring the amount of sulphur dioxide that produces a given amount of injury.

It would appear, therefore, that such methods of experimentation do not simulate field conditions of fumigation by smelter smoke nor would the data obtained from such experimental work be of great value in judging what concentrations of sulphur dioxide were necessary to produce a given amount of injury.

In the work undertaken by the commission to determine the effects of sulphur dioxide on plants it was deemed inadvisable to attempt experimentation with a variety of plants because of the limited time at the disposal of the commission for this work and because of the expense attendant upon a complete investigation of the subject. Accordingly all the energies of the commission were bent toward a complete investigation of one kind of plant. The plant chosen was barley. The choice was made for two reasons—barley is a commonly grown crop of the smoke zone, it being grown both for hay and for grain, and it is one of the most sensitive, if not the most sensitive, of the cultivated plants.

The experiments were planned in such a way as to use an actually cultivated field of barley, cared for in the manner generally practiced in the smoke zone, which was located just without the smoke zone in an area which is seldom, if ever, contaminated by smelter smoke. Analyses of the atmosphere in the neighborhood of the experimental field established fully and positively that the normal air of the field contained indeterminable amounts of sulphur dioxide; that is, less than 0.2 parts SO_2 per million parts of air. The field had been poorly prepared for the seed and the seed had been carelessly sown and indifferently attended after sowing. However, a fairly good stand of plants was in evidence as soon as the seeds sprouted and the blades appeared above the ground.

It was arranged to subject the experimental plats, which were about 4 feet wide by 20 feet long, to air containing varying amounts of sulphur dioxide, which air would continually surround the plants and through constant movement would be of uniform concentration during the fumigation, irrespective of the length of time of the fumigation. This condition was brought about by covering the plats with a cabinet constructed of a wooden frame and sheet celluloid, and passing air, previously mixed with known amounts of sulphur dioxide, through the cabinet at a uniform rate.

The amount of air passed through the cabinet was sufficient to produce a small excess pressure within the cabinet and thus obviate the possibility of the outside air gaining access to the cabinet and thus diluting the fumigating mixture. At the same time the passing mixture did not have sufficient velocity to agitate or disturb the

plants to a degree more than that caused by a gentle breeze blowing over them.

In order to check the concentration of the fumigating atmosphere analyses were made of the incoming and outgoing air mixture. The early experiments showed that there was a considerable loss of sulphur dioxide during the passage of the mixture through the cabinet. In subsequent experiments the loss was overcome by means of an improved mechanical arrangement for the delivery of the air mixture. In the detailed report of this work [a] the reasons for this loss of sulphur dioxide are shown to be absorption by the plant, absorption by the soil, absorption by the moisture on the plants and absorption on the walls of the cabinet. The bettered mechanical delivery supplied the air mixture at such a rate that the losses were distributed through a larger volume of air and consequently made the passing air mixture more nearly uniform throughout the cabinet.

The experiments were planned to furnish information upon the following points: First, the amount of visible injury caused by subjecting growing plants to definite concentrations of sulphur dioxide acting during definite lengths of time; second, the effect such injury has upon the total growth or ultimate yield of the crop, and the fertility of the seed; and, third, the existence of so-called "invisible injury" and the extent to which this occurs.

The investigation originally planned included the experimental fumigation of 106 plats at the station near the smoke zone.[b] The results obtained by the early experiments were so at variance with those reported by previous investigators that it was deemed advisable to duplicate the work in another part of the State. Through the courtesy of Dean Hunt of the College of Agriculture and Dean Van Norman of the university farm, permission was obtained to establish a station at the University of California farm at Davis. This set of experiments covered the fumigation of 35 plats. The data collected at each station have been kept separately and the two sets compare very favorably as duplicate work. It was found possible to duplicate any given result obtained at one station by the same conditions applied at the other station.

There are three factors that vitally influence the amount of injury that can be produced by sulphur dioxide. These three factors are: First, concentration of the sulphur dioxide; second, length of time of the application of the atmosphere containing the sulphur dioxide; and, third, the quantity of moisture or water vapor present in the atmosphere during the application of the fumigating mixture. The effect of light, although distinct, is of minor importance.

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[a] "Experiments to determine the effect of highly diluted sulphur dioxide upon a growing grain crop," by A. E. Wells (p. 213).

[b] For location see page 214 of this report.

It is obvious that high concentrations under otherwise similar conditions will produce greater injury than low concentrations, but owing to the variability of the field conditions it is impossible to say, without fixing these variables, that a given concentration will produce a given result.

The investigation developed the fact that, next to the concentration, the time during which the plants are exposed is the chief element in the causation of injury. This result seems a priori obvious. It was further found that the application of a given mixture of air and sulphur dioxide of definite humidity for a given period of time produced the same results if the time of fumigation was applied through a continuous treatment or if the same was applied within short intervals. Thus 5 parts SO_2 per million with a humidity of 40 applied for 1 hour continuously produces very acute injury of what is described in the detailed report as "concentrated" or "kill-back" type; and if applied for 10 minutes at intervals of 1 hour for 6 consecutive hours practically the same amount of injury is produced. However, when the interval between fumigations is increased the same concentration of sulphur dioxide under the same humidity conditions applied for 10 minutes during each of 6 consecutive days produces much less injury, or the "mottled" type.

It was conclusively shown by the investigation that the quantity of water vapor present in the atmosphere (humidity) is a strong determinative factor in the production of injury. Given concentrations in a dry atmosphere for the same periods of time did not produce as extensive injury as did the same concentrations in a moist atmosphere, although the work was not extended sufficiently in this direction to establish a relationship of a quantitative nature relative to humidity.

The experiments show that visible injury can be produced on barley under innumerable concentrations and conditions of humidity and time. The point at which no injury can be produced by a sufficient time of fumigation with very low concentrations and sufficient humidity could not be established. It is probable that if continued long enough very small concentrations of sulphur dioxide would produce a visible injury. It is believed that with a maximum of humidity (80 to 100 per cent of relative humidity) and a continuously applied atmosphere containing 0.5 parts SO_2 per million slight visible injury would result to barley plants before they had reached maturity. Under field conditions, however, no such conditions of humidity are approached during the entire period of growth of a field of barley. Nor is any area in the smoke zone continuously bathed with air containing anywhere near 0.5 parts SO_2 per million parts of air. Injury may be done under any number of sets of circumstances which are not impossible of occurrence within the

Selby smoke zone, but are highly improbable of occurrence. The best that can be done in the matter of statement of the liability of damage being produced in the smoke zone is to consider the probability of any set of conditions occurring within the zone.

A consideration of all of the data collected in the investigation leads the commission to the belief that a fumigation of barley with an atmosphere containing 20 parts SO_2 per million parts of air if applied for 15 minutes under the average conditions of humidity of the smoke zone will produce very acute injury of the "kill-back" type. Under the same humidity conditions 10 parts SO_2 per million will produce the same amount of injury in 30 minutes, while a like amount of injury will be caused by 5 parts SO_2 per million persisting for an hour with the same humidity conditions.

At no time within a period of 8 months was the concentration of sulphur dioxide in the smoke zone found to be as high as 10 parts per million of air. It is doubtful whether such a condition has ever existed in the smoke zone, and unless the smelter increases decidedly in its capacity (a subject which will be separately considered) such a concentration persisting for the period of time required to do damage—that is, one-half hour—would be, in the opinion of the commission, very unlikely.

The records of Mr. Wells show that on one day at station 2 a concentration of sulphur dioxide between 5 and 7 parts per million persisted for a period of 35 minutes, and that a rough average of 2.5 parts per million prevailed for 4 out of the 6 hours of the day during which tests were made. Such conditions have been shown to produce distinct injury to growing barley, and if repeated a sufficient number of times may seriously diminish the crop yield.

However, it is to be noted, first, that station 2 is so situated on the high hills above the Straits of Carquinez as to receive a maximum effect from the smelter when the wind is blowing toward the smoke zone; second, that the atmospheric conditions at the time were such as to cause the smoke stream from the smelter to drift slowly past the station; third, that on this day the smelter, at the request of the commission, was emitting a maximum amount of sulphur dioxide; fourth, that at no other time did those conditions recur during the period of the commission's investigations; and, fifth, that, except the slopes of the hills facing Carquinez Straits, there are no areas within the smoke zone likely to be bathed by such concentrations of sulphur dioxide.

It is therefore obvious that the probability of economic damage to growing crops, even in the more exposed parts of the smoke zone, is remote. The probability of economic damage in the less exposed areas is still more remote, if not absolutely nil.

Passing, now, to a consideration of the injury that might be done by concentrations of sulphur dioxide as high as 2 parts per million, which were found to exist in the area on 21 occasions, what are the probabilities?

It is a fact that under certain conditions considerable visible injury and even economic damage can be produced by 2 parts SO_2 per million. If such concentration is applied continuously for 4 hours under average humidity conditions, or for 10 minutes daily during the entire growing season, some visible injury is produced. The effect of such visible injury on the ultimate yield is, however, very slight.

The data concerning the sulphur dioxide content of the atmosphere show that a concentration of 2 parts SO_2 per million never endured for a period of over 30 minutes, and that the total time such concentrations existed was not greater than 3½ hours during the entire period. Although it is true that an application of 2 parts SO_2 per million for one-half hour under especially unfavorable conditions produces slight injury, such slight injury does not reduce the yield and has no economic importance.

It is the opinion of the commission that the probability of the concentrations of SO_2 in the atmosphere being at 2 parts per million for a sufficiently long-time fumigation, or in sufficient number of repeated short-time fumigations to produce visible injury, is very remote.

With concentrations of 1 part SO_2 per million it was found that although a slight visible injury resulted from two 7-hour fumigations, it was also found that six 7-hour fumigations, or ninety 10-minute fumigations, produced no determinable decrease in yield.

As the total time during the whole period that the concentration in the area was found to be 1 part SO_2 per million or more was only 1,220 minutes, and this total time was divided between 17 days in 8 months, it is considered highly improbable that any economic damage to growing crops could result in the smoke zone by the existence of such concentration.

Furthermore, a consideration of the length of time of application and the number of applications required to produce any visible injury with 0.5 part SO_2 per million, together with the longest period of time such concentration was found to be present continuously, or the number of times it was found for shorter periods, leads the commission to conclude that there is no possibility of economic damage resulting in the area from that low concentration.

Therefore it is the opinion of the commission that the sulphur dioxide which is emitted by the Selby smelter and is carried by the winds over the smoke zone is not a nuisance with reference to its action on vegetation by the reduction of yields of crops when the maximum output of sulphur from the plant does not exceed 40 tons

per day. It is the opinion of the commission that at any time during the operation of the smelter wind conditions may occasionally obtain whereby slight visible injury may be done to the most susceptible plants in the more exposed areas of the smoke zone by sulphur dioxide existing in the smoke of the Selby smelter; but that this slight visible injury is of no economic importance for the reason that the yield of crops is not diminished by such slight visible injury, nor is the vegetation so injured detrimental to the health of stock.

If with slight or even heavy visible injury there results no economic damage, it is difficult to see how any invisible injury which may result can be productive of economic damage as expressed in decreased yields of crops and decrease in the fertility of the seeds.

Finally, attention is called to the fact that the commission's plant pathologists, Dr. Blankinship and Prof. Jones, each after careful and repeated examination of the whole area included within the smoke zone, have reported a few instances of sulphur dioxide injury—in such slight amount, however, as to be economically of no significance whatever. Both these experts agree that during the period of the commission's investigations no economic damage was done to growing crops by sulphur dioxide emanating from the Selby smelter.

THE EFFECT OF SULPHUR DIOXIDE ON MATERIALS MADE OF IRON.

One of the common sources of complaint within the smoke zone has been that wire screens and barbed wire, which is put in use in the area, deteriorates very rapidly on account of the presence of the smoke from the smelter. There is no doubt as to the fact that these materials do deteriorate rapidly in the smoke zone, but such deterioration is not due, in the opinion of the commission, to the action of the sulphur dioxide which exists in the atmosphere so much as to the heavy fogs existing in the area. These fogs carry considerable water; and the so-called salt air, in combination with the water, cause much corrosion of iron and steel, particularly the latter. This fact, when considered in the light of the modern method of manufacture of wire screen and barbed wire, readily explains why these materials deteriorate more rapidly than they used to. The past 15 years have been productive of a great increase in the amount of steel used in the manufacture of wire and wire goods and a great decrease in the amount of iron wire and wire goods produced. Steel deteriorates when subjected to intermittent moistening much more rapidly than does iron. This corrosion is a condition noted all over the country and is particularly evidenced in regions of heavy fogs and heavy dews far away from smelters.

In the opinion of the commission the sulphur dioxide of the smoke from the Selby smelter, although it probably does exert a slight

effect when it is present in the atmosphere of the smoke zone, in the deterioration of iron and steel through corrosion is of so slight importance as to be worthy of no consideration in connection with the existence of a nuisance which may be maintained by the Selby smelter through its smoke.

PLANT PATHOLOGICAL SURVEY OF THE SMOKE ZONE.

For the determination of the conditions existing in the smoke zone as regards the crops of various kinds and the many kinds of plant life found therein, the commission engaged the services of Dr. J. W. Blankinship and Prof. W. W. Jones, plant pathologists of a high degree of training and of extensive experience in the study of plants in relation to smelter-smoke injury. Each was commissioned to make a complete plant pathological survey of the area, reporting all abnormal conditions which exist, and to trace wherever possible the actual cause of such conditions. The investigations of these experts were carried on independently, each being free to draw such conclusions as he deemed the proper ones relative to the general conditions and to such specific conditions as were covered by his work.

In general summary, the two experts are agreed that the Selby smoke zone, in comparison with areas of the same size in the Western States, shows a larger number of plant diseases and other adverse influences which affect the health of plants. So far as could be discovered, no attempt is made by the farmers of the smoke zone to combat or cure these diseases; whereas in most other sections some effort is made to rid the area of such conditions. No disease was found to be prevalent in the Selby smoke zone which is not also found in other areas. In other words, the smoke zone contains no typical or specific diseases which might find within a smoke zone the conditions favorable for their growth.

Many diseases, such as root rot and various fungus diseases, which prevent a normal, not to mention maximum, development of the trees, exist in the smoke zone. These plant diseases, taken in conjunction with a general lack of care of the trees, with poor cultivation and improper preparation of the soil, and the rather low annual rainfall of the area, do not make for great growth in the trees nor for much productiveness. The grain crops are, for the most part, infested with fungus diseases of various kinds and of more or less virulence. The most prevalent disease of this character is known as Helminthosporium. A bacterial blight is also very common in the area. These conditions, together with poor methods of cultivation and preparation of the seed bed, very markedly decrease the yield of barley, wheat, and oats by depriving the plant of its proper nourishment at its critical stage of growth. The appearance of the

leaves of the affected plants are in many instances similar to that of leaves damaged by sulphur dioxide, with the result that the two are often confused by the untrained observer.

The deplorable condition of the numerous Monterey cypress in the area is shown by Dr. Blankinship to be due to the effects of any one or more of a number of diseases and pests and not at all to smelter smoke.

The condition which obtains in relation to the fruit trees of the region is caused by the ravages of diseases such as "shot-hole disease," "wood rot," "pear blight," "crown gall," "gummosis," "leaf curl," and "mildew" and the inroads of many kinds of insects, acting in conjunction with poor cultivation and a lack of effort to combat them. Smelter smoke as it exists in the area does not influence the growth of fruit trees for good or for ill. The same can be said of the shade and ornamental trees of the area. In these latter varieties drought and grass fires have caused a lessening of the vitality of the trees and, when not killing them outright, have laid the trees open to easy attack by diseases and insect pests.

Both investigators, during their observations, discovered evidence of slight smelter-smoke injury to the native herbiage and to barley and oat plants. In no case was the damage sufficiently in evidence to be noticed except by an expert who was searching for it. Along the shore of the area and on the high bluffs directly across from the smelter and on the Dos Reis place this small amount of injury was noted shortly after a rain, but in no case was it, in the opinion of the experts, sufficiently marked to be of any economic importance. The injury was not general in any sense but confined to a few plants widely scattered and would not be productive of the amount of damage that would be done by one head of stock breaking into a grain field and grazing for one minute. Injury due to sulphur dioxide, even in such slight degree, was not found in what can be described as the real agricultural centers of the smoke zone. No evidence of sulphur dioxide injury was noted by either investigator on any of the trees of the area nor on the shrubs or vines. Every pathological condition of the vegetation of the area is accounted for either by disease, insect pests, cultural conditions, drought, or untoward conditions other than sulphur dioxide.

The commonly occurring sootlike deposit on the trees of the smoke zone, which is believed by many of the farmers to be deposited from the smoke of the smelter, is clearly shown to be a mold which grows in the honey dew secreted by certain predacious insects which infest the trees. Direct microscopical examination of this sootlike deposit also shows it to be chiefly of organic nature and not of the inorganic nature of the solid particles of smelter smoke.

It is the opinion of the commission that the only conclusion which can be drawn from the work done in the plant pathological survey is that the poor conditions of growth of many kinds of vegetation in the smoke zone are directly traceable to one or more of the following causes: Plant diseases, predacious insects, poor soil, poor cultivation, lack of water, and indifference to all of these conditions by the farmers of the area. None of the conditions existing so far as vegetation is concerned can be attributed to the effects of the smoke from the Selby smelter which blows over the area, known as the smoke zone.

ENTOMOLOGICAL SURVEY OF THE SMOKE ZONE.

For the investigation of insect injury to vegetation in the smoke zone the commission engaged R. W. Doane, professor of entomology of Leland Stanford Junior University, to make an entomological survey of the area. Prof. Doane began his work late in the fall (1913) when most of the predacious insects are lying dormant and at a period when a portion of the damage suffered by the trees during the preceding period of insect activity could be advantageously observed. His investigations extended through the winter and spring months and well into the early summer, so that the seasons of activity of most of the various insects were fully observed.

The investigations of Prof. Doane established the fact that much of the poor condition of the trees and crops of the smoke zone is due to the work of insect pests. He finds that in the large majority of cases no attempt is made by the farmers of the area to combat these insect pests and that the lack of care in this direction is responsible for the remarkable prevalence of them. The indifference of the farmers to these conditions is illustrated by the fact that during his investigations Prof. Doane volunteered to advise certain farmers free of charge as to the proper methods of combatting insects and to supervise their attempts if they would but make the attempt. However, none took advantage of the opportunity to improve the existing conditions.

No less than eight varieties of scale insects were found to occur in sufficient numbers to exert a marked influence for ill on the growth and productiveness of fruit trees and ornamentals. Four varieties of aphis were found to be abundant. The green aphis and the woolly aphis were present in some of the orchards in numbers greater than ever before encountered anywhere by Prof. Doane. Aside from the 12 varieties of insects mentioned above, 13 other varieties were found to be prevalent and doing more or less damage to plants of all kinds.

In some instances the death of trees was traced directly to the activities of insect pests, and in all cases in which trees were found to

be languishing insects have been a contributary cause of their ill condition. Insect pests were found to have inflicted much damage on the ordinary garden truck grown in the district for home consumption, and but little if any effort is made by the growers to stay the ravages of these pests.

One very serious pest was discovered in this entomological survey in conjunction with the work of the plant pathologists, namely, the Hessian fly. This pest has caused immense amounts of damage in various grain-growing areas of the world and its advent in a hitherto untouched region is a circumstance of greatest moment if the area is of agricultural importance.

At the request of the commission and in the hope that the work would prove an object lesson to the farmers and residents of the smoke zone, Prof. Doane directed several spraying experiments to show the people of the smoke zone how to combat insect pests. His experiments showed clearly that the trees treated were in much better condition than the untreated trees, particularly as regards the "sooty deposit" always referred to by the farmers as being due to smelter smoke. At this writing it is too early to determine what effect the object lesson will have. It is to be hoped that the owners of the orchards in the smoke zone will follow the advice of Prof. Doane and make serious efforts to rid their orchards of these pests.

The Selby smoke zone is about at the average of other neglected California farming areas in the matter of the number and prevalence of insect pests. It can not be expected that trees heavily infested with insects, which live upon the sap and juices of the trees, can be productive nor can they be healthy and vigorous. As well expect cattle covered with ticks and other parasites to thrive and be marketable as prime cattle as to expect a fruit tree to produce fine fruit when a large portion of its energy is expended in overcoming the attacks of insect pests.

The commission is of the opinion that the general conclusion to be reached from a consideration of the data collected by the entomological survey is that poor care, as expressed by lack of cultivation, lack of proper pruning, lack of spraying and fumigation with insecticides, and slipshod methods of farming, is mainly responsible for the bad conditions which exist in the Selby smoke zone as to trees, crops, and vegetation in general.

AGRONOMIC AND SOIL SURVEY OF THE SMOKE ZONE.

The preparation of a report on the agronomic conditions of the smoke zone and on the question of the possible contamination of the soil by smelter emanations was given over to Charles F. Shaw, professor of agronomy of the University of California, and Mr. E. E. Free, agronomist and soil expert of San Francisco.

The problems presented to these experts were: First, are the agronomic conditions of the smoke zone such as to permit high agricultural development; second, is there in the smoke zone any soil trouble which is responsible for any poor condition of plant growth which may exist; third, has the soil of the smoke zone been polluted by materials deposited there from smelter smoke; fourth, if such pollution exists is it of economic importance; does it influence adversely the growth of crops or other vegetation.

The findings of Messrs. Shaw and Free show that the soils of the smoke zone can not be regarded as of high quality nor even up to the average of good farming areas. They lack diversity of mineral constituents and are consequently poor in plant-food materials. The soils are shallow and have only small capacity for the storage of water and for the accumulation of humus. The annual rainfall of the areas is low for the requirements of the kind of soil that is found in the area and the careless and poorly thought out methods of agricultural practice that are in vogue do not conserve the rainfall nor do they tend to increase the capacity of the soil for water storage or for the accumulation of humus. The soils do not contain alkali.

The yields of crops in the area are below the average for areas in other sections of the State having a similar climate. The poor quality of the soil and the poor agricultural practices are sufficient to account for the existing bad conditions as to crops and crop yields. No soil trouble exists other than the poor quality of the soil, to which the existing conditions of plant growth can be traced.

In the matter of soil pollution an extensive investigation was conducted. Samples of soil were taken from various parts of the area and subjected to examination to determine the presence of lead and arsenic. If the soil is polluted by emanations from the smelter, these metals are the elements in the smoke that would cause the pollution.

The results of the investigation point to the fact that both arsenic and lead are natural constituents of the soils of the smoke zone and of the country surrounding the smoke zone as far away as 15 miles or more. The amounts of these metals which occur naturally in the soils of the smoke zone are, however, very small. It was found that on the bluffs overlooking the Straits of Carquinez and in the more directly exposed areas there has without doubt been pollution of the soil by the emanations from the smelter. Both lead and arsenic occur here more abundantly than in the soils of the regions of the smoke zone more remote from the smelter. On account of these substances (lead and arsenic) occurring normally in the soil and in variable quantities, it is impossible to say what portion of the lead and arsenic found in the soils was deposited from the smoke from the Selby smelter and what portion occurs normally. It is estimated by these

experts that the amount of these substances which has been added to the soil through the agency of smelter smoke is about the same as is normally present in the soils. What the source of arsenic and lead found in the soils both of the exposed and the unexposed areas may have been is a matter of no particular importance in the present connection because the quantity present is not sufficient to be a factor which would influence the growth of plants for good or for ill. In the opinion of Messrs. Shaw and Free the soils of the smoke zone are not "poisoned" by substances deposited upon the soil from smelter smoke.

To substantiate their conclusions in the matter, Messrs, Shaw and Free submitted their findings and data to Charles B. Lipman, professor of soil chemistry and bacteriology in the University of California, asking his opinion as to the possibility of the stated amounts of arsenic and lead which occur in the soils of the smoke zone having any influence on the growth of plants. Prof. Lipman states emphatically, and bases his statement on the results of his own investigations, that such quantities of arsenic and lead have no adverse influence on the growth of plants, that indeed such small quantities seem rather to stimulate their growth.

Substantiating the opinion of the agronomists is the agronomic record kept by Mr. Ralph W. Brown during the period of the survey. Even casual inspection of this record points strongly to the fact that the agricultural practices of the smoke zone are not good; in fact, they are such that it is small wonder that large yields of crops are not common, and on the whole it is remarkable that the crops yield as well as they do.

Supplementing the agronomic survey, the commission collected data which throw some light on the amount of arsenic and lead which has been deposited from the smoke of the Selby smelter upon the smoke zone. This investigation is detailed in the reports of Mr. Wells [a] and was undertaken in the hope of determining some of the conditions that may have existed in the past.

An attempt was made to measure the deposition of solids from the smoke by catching on glass plates the dust carried in the atmosphere of the area. These tests were made prior to the installation of the bag house for the roaster stack, which clears all of the smoke coming from the plant of its visible element, and are of interest in showing that contamination of the soils and vegetation of the area has undoubtedly taken place in the period which antedates the installation of the bag house.

The amount of dust collected within the time the experiments were carried on proved to be unimportant from the point of view of con-

[a] See pp. 181–188.

tamination of the soil to the point of damage to it. Using the figures obtained as a basis for calculation, it develops that the amount of lead, for example, which would be deposited on the top 2 inches of soil in a year's time would be 0.4 part per million of soil, if all of the area of the smoke zone were evenly covered with dust deposited at the same rate as occurred on the test plate showing the maximum of deposition. According to the investigations of Prof. Lipman, made independently of the commission's work, this amount must be increased 3,000 times before the presence of lead in the soil becomes toxic or injurious to plants or in any way interferes with their growth.

The commission finds that the soil of the smoke zone contains lead and arsenic as natural constituents, and that the operations of the Selby smelter have resulted in slight additions to the quantities of these metals normally present. It also finds that, as at present operated, the smelter smoke contains nothing more than traces of these metals. Finally it finds that the amounts of lead and arsenic in the soils of the smoke zone are so small that they are without effect upon vegetation growing in the smoke zone.

The commission is, therefore, of the opinion that no nuisance exists at the present time as a result of the presence of lead or arsenic in the soil of the smoke zone, nor has one ever existed so far as "poisoning" of the soil is concerned.

VETERINARY SURVEY OF THE SMOKE ZONE.

Dr. C. M. Haring, professor of veterinary science at the college of agriculture, and Dr. Karl F. Meyer, of the department of pathology of the medical school of the University of California, made a careful examination into the conditions in the smoke zone as affecting the health of farm animals.

This veterinary survey included the identification of every horse and the enumeration of all of the other domestic animals within the zone. The work of identification and classification of the animals by the card-index system of cataloguing was done by Mr. William La Grange. The listing of the horses developed the fact that 31 horses out of a total of 308 within the smoke zone were suspected as being of the type known as "roarers." Of these 31 suspects, 12 cases were diagnosed as "roarers" by the veterinarians. Of the remaining 19, 8 were claimed by the owners to be "smeltered," but no evidence was found by the veterinarians to support the claims. Eleven of the 19 cases were suspected by the veterinarians as being "roarers," but 5 of these were necessarily left without further diagnosis because objections were raised by the owners to the veterinarians making any serious and careful study of them. In the remaining 6 cases the evidence obtained was not sufficient to establish a diagnosis.

The condition known as "roaring" in horses is brought about by various circumstances and contributory causes. Among these contributory causes it is known that chronic lead poisoning is very common. In order to determine to what extent the animals, which were under suspicion, were suffering from possible chronic lead or arsenic poisoning, it was necessary to make a complete and systematic study of each one. The unwillingness of certain owners to permit study of suspected animals shows little desire on their part to be instrumental in securing an equitable settlement of the litigation which has heretofore existed, and leads the commission to believe that their cupidity and desire to misrepresent conditions for their own monetary benefit was with them the paramount issue. Despite the reprehensible attitude in declining to permit the veterinarians to examine their animals, these owners were insistent that their horses had been "smeltered." These cases are listed as suspects, because their owners claimed they had been "smeltered." The commission is firmly of the opinion that none of the owners who objected to a study being made of their stock is sufficiently qualified as a veterinarian to diagnose "smeltering," and as a consequence no weight shall be given by the commission to the statements of such owners as to animals having been "smeltered." If the owner honestly believes his animal is injured, there can be no valid reason why he should object to a study for the purpose of establishing the fact.

A complete and systematic study of the conditions of the 12 horses which were suspected by the veterinarians of being "roarers" was made during the course of the survey. Diagnosis of these cases disclosed in every instance that the animal was afflicted with the trouble suspected. Two of the animals were killed and autopsied and the autopsy confirmed the diagnosis. Two of the cases were taken to the university farm at Davis and were operated upon for the correction of the trouble. One case recovered and one case was much improved, but was not sufficiently benefited by the operation to pass as cured.

"Roaring" is brought about directly by the paralysis, either partial or complete, of certain muscles of the throat and neck. This paralysis causes improper functioning of the respiratory organs, so that during exercise or when at rest immediately after exercise the animal breathes with a peculiar roaring sound. The animals seldom succumb to the direct effects of the roaring, but owing to the improper functioning of the respiratory organs they are subject to attacks of pneumonia, which usually ends fatally. Another direct cause of death in "roarers" is the lodgment of food in the lungs owing to the paralyzed condition of the muscles of the throat. Such conditions bring about complications and the animal generally dies of some acute attack on the respiratory organs.

It is known that ingestion of lead with food produces the condition of paralysis above referred to. Other things also cause it, but the proportion of "roarers" is usually greater in the vicinity of industrial plants which give off lead or lead compounds than in areas not so situated.

During the course of the investigations two horses died in the area from pneumonia which was superinduced by the weakened condition of the animals, which condition was undoubtedly due to a paralysis caused by the ingestion of lead with the food. The cases were of long standing, and it is probable that the paralysis has been a long time developing to the point which would produce a "roarer" from the otherwise healthy animal.

In considering the occurrence of "roaring" in the smoke zone the veterinarians have divided the zone into two portions—one, that part which is obviously directly exposed to the smoke from the Selby smelter, and the other the unexposed or less directly exposed section of the smoke zone. Within the obviously exposed area there were enumerated 140 horses. Of this number 12 were positively diagnosed as "roarers." It can be positively stated that the exposed areas of the smoke zone contain 8.5 per cent, at least, of "roarers." This figure is considered high by the veterinarians for the proportion of "roarers" present in average areas. From the fact that 11 additional cases were suspected by the veterinarians and 8 cases were claimed by the owners to have been "smeltered," none of which were fully studied from one cause and another, it is quite certain that the proportion of "roarers" in the entire zone is higher than the above percentage would indicate.

In the opinion of the veterinarians the condition of these "roarers" was due to the effects of the paralysis above referred to, which paralysis was directly brought about by chronic lead poisoning.

It is the opinion of the commission that the smoke from the Selby smelter has in previous years carried lead or lead compounds which have been deposited upon the area, and it must be assumed that at least some of these animals have been injured by lead deposited from smelter smoke. In the opinion of the veterinarians none of the studied cases is of recent origin.

Irrespective of what the conditions have been in the past in regard to the deposition of lead upon the area, such conditions have not obtained since April, 1914, nor will they obtain in the future if present operating conditions continue, as the roaster-stack bag house removes the last visible smoke, and hence eliminates all possibility of subsequent deposition of either lead or arsenic upon the area.

POSSIBILITIES OF LESSENING THE OUTPUT OF SULPHUR DIOXIDE.

As referred to in the fore part of this report the studies conducted at the smelter were productive of a recommendation by the commission October 25, 1913, that apparatus be installed to remove all of the visible portion from the smoke being discharged from the plant. It was believed necessary by the commission, in order that full information might be at hand upon which to base recommendations for the subsequent operation of the smelter in the event that a nusiance was found to exist within the smoke zone, to make certain studies to determine the possibility of eliminating the sulphur dioxide from the smoke of the plant before it is sent into the atmosphere.

These studies were made upon that part of the metallurgical processes of the plant known as "roasting." It was found that, by the introduction of more complete control of the constituent parts of the charges roasted and sintered on the Dwight & Lloyd sintering machines, it was possible to operate the machine in such a way as to drive off at certain points of the machine the greater part of the sulphur contained in the charge in a manner which would easily permit of its subsequent elimination from the discharged smoke. These conditions were also found to produce a product from the charge which was much better adapted for the subsequent metallurgical operations to which the sintered material is subjected, and to that extent, at least, the metallurgical practices of the plant can be improved. The driven-off sulphur, in the form of sulphur dioxide, was found to be susceptible to easy concentration to such percentages of sulphur dioxide as would make it possible, technically, to utilize the gas for the production of either sulphur, sulphuric acid, or liquid sulphur dioxide. The details of the study need not be discussed in this report, but can be left to the report of A. E. Wells.[a]

Although the commission finds that no economic damage is being done by the comparatively small amount of sulphur dioxide now emanating from the plant of the Selby Smelting & Lead Co., it is nevertheless cognizant of the prospect that there will always be objections raised to the discharge of even moderate quantities of sulphur dioxide into the atmosphere of farming and thickly populated regions. The commission shares these objections and entertains a firm conviction that all smelting plants should do their utmost to find ways and means of avoiding the escape of sulphur dioxide into the atmosphere, and that in cases of obvious neglect of

[a] Report of investigations on the gases from Dwight & Lloyd sintering machines at the Selby smelter, pp. 324-337.

duty in this respect the people should take steps to bring the offenders to a realization of their obligations to the community in which they operate. With present conditions in mind and looking confidently forward to a steadily increasing population and growth of the varied industries of this region, the commission recommends that the Selby Smelting & Lead Co. make an earnest effort to reduce the amount of sulphur dioxide now discharging into the atmosphere from its smelter as soon as it is practicable to do so by the production of either sulphur, sulphuric acid, or liquid sulphur dioxide.

CONCLUSIONS AND FINDINGS.

The commission concludes:

1. With respect to the visible element of the smoke from the Selby smelter:

(*a*) That prior to April 1, 1914, a nuisance, measured by the cumulative injury done to certain horses, was maintained in the smoke zone.

(*b*) That the installation of the bag house in connection with the sintering machines of the smelter has resulted in the abatement of this nuisance.

(*c*) That lead and arsenic from the smoke of the Selby smelter was deposited on the soil of the smoke zone during the period of time included between the beginning of operations of the smelter and April 1, 1914, but that the quantity of these metals so deposited was of no economic importance and did not poison the soil or in any way produce a loss or reduction of crops.

(*d*) That the blackened appearance of many trees and plants in the smoke zone, which appearance is believed by many of the residents of the smoke zone to be due to a deposit of lead from the smelter smoke, is in fact not due to such cause. The so-called "lead deposit" results from the growth of a mold within the honeydew secreted by certain insects which infest the trees and plants and contains no lead whatever.

2. With respect to the sulphur dioxide contained in the smoke of the Selby smelter:

(*a*) That the Selby smelter has not maintained a nuisance with respect to producing within the smoke zone a disagreeable or objectionable odor, or with respect to disagreeably or injuriously affecting the throat and lungs of human beings or domestic animals living in the smoke zone.

(*b*) That the rare instances during the investigations of the commission when sulphur dioxide from the Selby smelter was present in the smoke zone in sufficient concentrations to be observed by the residents by the sense of smell do not constitute a nuisance; nor do

these rare visitations prevent the residents of the smoke zone from the peaceful enjoyment of life and property.

(*c*) That the Selby smelter has not maintained a nuisance with respect to economic damage to trees, vines, shrubs, or growing crops of any kind within the smoke zone.

(*d*) That the Selby smelter has not maintained a nuisance with respect to the corrosion of wire screens or barbed wire in use within the smoke zone.

3. With respect to the future operation of the Selby smelter:

(*a*) That so long as the mechanical devices now used at the Selby smelter for clearing the smoke of the plant of its visible element are kept in operation the Selby smelter will not maintain a nuisance with reference to injury to horses or other domestic animals, or with reference to injury to the soil of the smoke zone; nor will a nuisance be maintained by the Selby smelter in these respects so long as the visible element is removed from the smoke by any means, mechanical or otherwise.

(*b*) That the apparatus now installed at the Selby smelter which are used to eliminate the visible element of the smoke are subject to accident and are so constructed as to require occasional cleaning and repairing; and that, for the purpose of cleaning and repairing the apparatus so used, the Selby Smelting & Lead Co. will not maintain a nuisance in the smoke zone if it discharges visible smoke from the blast-furnace stack for a total period of no more than 48 hours in any one month of each calendar year; or if it discharges visible smoke from the roaster stack for a total period of no more than 48 hours in any one month of each calendar year.

(*c*) That during that portion of the year known as the "closed season"—that is, from March 15 to November 15 of each year—the emission of smoke into the atmosphere from the furnace known as the Ropp roaster will be productive of a nuisance in the smoke zone unless the visible element is removed from the smoke before it is discharged into the atmosphere.

(*d*) That so long as the total output of sulphur dioxide which is discharged through all of the stacks of the Selby smelter into the atmosphere is less than 80 tons per day of 24 hours during each hour of which day less than 3⅓ tons of sulphur dioxide are discharged the smelter will not maintain a nuisance with respect to a disagreeable or objectionable odor or with respect to disagreeably or injuriously affecting the throat and lungs of human beings or domestic animals living within the smoke zone; that the smelter will not maintain a nuisance with reference to economic damage to trees, shrubs, vines, or growing crops of any kind growing within the smoke zone; that the smelter will not maintain a nuisance with reference to the corro-

sion of wire screens or barbed wire in use within the smoke zone; and that no nuisance of any kind will be maintained within the smoke zone with respect to sulphur dioxide under the above-stated conditions of operation.

The commission therefore finds, and so makes answer to the requirements of the stipulation, that the Selby Smelting & Lead Co. in the operation of its plant near Vallejo Junction, Contra Costa County, Cal., was, at the time of the organization of the commission, violating the terms of the decree of the injunction issuing from the Superior Court of Solano County, Cal., and was maintaining a nuisance with respect to cumulative injury to certain horses within the area of the southern portion of Solano County heretofore designated as the smoke zone; but that in installing proper apparatus for the elimination of the visible element of the smoke discharged from the plant the said Selby Smelting & Lead Co. has since April 1, 1914, complied in all respects with the terms of the decree of injunction both in letter and in spirit, and has not since that time and up to the present time, November 6, 1914, violated the terms of the said decree or maintained a nuisance in the area of the southern portion of Solano County, Cal., heretofore designated as the smoke zone.

The commission finds and makes known that, by continuing the elimination of the visible element from the smoke discharged into the atmosphere from its plant near Vallejo Junction, Contra Costa County, Cal., and at all times maintaining the total output of sulphur dioxide from said plant at less than 80 tons per day of 24 hours, during each hour of which day less than 3¼ tons of sulphur dioxide are discharged, during the period of each year covered by the said injunction decree, then the Selby Smelting & Lead Co. will not violate the terms of the said decree of injunction and will not maintain a nuisance within the area of the southern portion of Solano County, Cal., heretofore designated as the smoke zone.

The commission finds and makes known that, by discharging visible smoke from the blast-furnace stack, during the cleaning or repairing of the apparatus by which the visible smoke is eliminated, for a total period of no more than 48 hours in any one month of the period covered by the said decree of injunction; or by discharging visible smoke from the roaster stack, during the cleaning or repairing of the apparatus by which the visible smoke is eliminated, for a total period of no more than 48 hours in any one month of the period covered by the said decree of injunction the Selby Smelting & Lead Co. will not violate the terms of the said decree of injunction and will not maintain a nuisance within the area of the southern portion of Solano County, Cal., heretofore designated as the smoke zone.

The commission finds and makes known that, if the Selby Smelting & Lead Co., as the result of conditions of operation that may arise in the future, desires to use the furnaces known as the Ropp roaster during the period known as the "closed season," then, if the smoke from the said furnace is so treated before it is discharged into the atmosphere as to remove the dust and fume therefrom, the said company will not violate the terms of the said decree of injunction and will not maintain a nuisance within the area of the southern portion of Solano County, Cal., heretofore designated as the smoke zone, during the period covered by the said decree of injunction.

FINANCIAL REPORT.[a]

By N. M. Porter.

The financial transactions of the commission have been accurately recorded and are herewith submitted. The time covered is from May 1, 1913, to December 1, 1914. The funds received amount to $27,000.

Appended to this report is the statement of the certified public accountant who has audited the books.

The following is a general summary of the costs of the various investigations:

General chemical investigations on composition of atmosphere and conditions at smelter	$11,205.58
Plant pathological survey and fumigation experiments	4,040.22
Agronomic and soil survey	2,516.80
Entomological survey	707.55
Veterinary survey	725.18
Bibliography	454.50
Travel	2,003.92
Office expense	2,421.90
Miscellaneous expense	1,529.39
Equipment	2,317.36
Total	27,922.40

Balance sheet, Selby Smelter Commission, November 30, 1914.

Item.	Debit.	Credit.
Wells Fargo Nevada National Bank	$142.44	
Selby Smelting & Lead Co		$21,000.00
Personal services	17,104.86	
Office expenses	1,191.90	
Equipment	2,317.36	
Field expenses	7,308.28	
Interest and discount		1.24
Solano County Board of Supervisors		6,000.00
Sales of equipment		1,063.60
Total	28,064.84	28,064.84

[a] Dated Dec. 1, 1914.

STATEMENT OF PUBLIC ACCOUNTANT.

SAN FRANCISCO, *December 1, 1914.*

MR. RALPH A. GOULD,
Secretary Selby Smelter Commission,
San Francisco, Cal.

DEAR SIR: In accordance with your request, we have made an audit of the books, accounts, and records of the Selby Smelter Commission from May 23, 1913, to November 30, 1914; have verified the cash account by certificate from the depository; have ascertained that all payments are covered by sufficient vouchers, and

We hereby certify that the attached statement of receipts and disbursements, for the period indicated, agrees with the books and is correct.

Herewith please find Exhibit A, "Statement of receipts and disbursements of Selby Smelter Commission for the period May 23, 1913, to November 30, 1914."

Yours, truly,

HASKINS & SELLS,
Certified Public Accountants.

Selby Smelter Commission—Statement of receipts and disbursements for the period May 23, 1913, to Nov. 30, 1914.

RECEIPTS.

Selby Smelting & Lead Co.		$21,000.00	
Solano County		6,000.00	
Discount		1.24	
Total receipts			$27,001.24

DISBURSEMENTS.

Personal services		$17,104.86	
Field expenses		7,308.28	
Office expenses		1,191.90	
Equipment	$2,317.36		
Less sales	1,063.60		
		1,253.76	
Total disbursements			26,858.80
Balance Nov. 30, 1914			142.44
Consisting of deposit, Wells Fargo Nevada National Bank			142.44

CONDITIONS IN AND AROUND THE SELBY SMELTER AND THE SELBY "SMOKE ZONE."

By A. E. Wells.

INTRODUCTION.

A large proportion of the ores containing lead and copper together with the precious metals, gold and silver, treated at the various reduction plants of this country also contain more or less sulphur. This sulphur is usually present as sulphide of iron, lead, copper, or zinc. In the treatment of those ores most of this sulphur is oxidized to sulphur dioxide or to sulphur trioxide and as such is eliminated from the smelters through the waste gases. The sulphur dioxide is discharged into the air as a gas. The trioxide unites with the moisture present in the smelter emanations or in the outside air and forms fine particles or mist of sulphuric acid.

In the treatment of these ores in the various types of furnaces there are formed two other products, which, if not recovered, are discharged into the atmosphere as smoke. These two products are flue dust and fume. Flue dust consists of the fine particles of the furnace charge that have been driven off or drawn off mechanically by the gas currents. Fume consists of metals or metallic compounds that have been volatilized at the high temperatures of the furnaces, condensed at lower temperatures, and carried by the furnace gases into the flues. Sulphur trioxide and elemental sulphur, driven off from the furnaces and condensed, are also classed as fume.

The possibility of smelter emanations contaminating the atmosphere of areas contiguous to smelters to such an extent as to constitute a nuisance to people or a cause for damage to vegetable or animal life is dependent upon a number of conditions. Few of these conditions are the same in the case of different smelters, and it is not possible to enumerate the determining factors in an order of relative importance applicable in all cases.

In general, the rate and concentration at which these emanations are discharged from a smelter is the chief factor which determines whether their concentration in the atmosphere is sufficient to cause trouble. However, there are other factors of such great influence that, with the same quantity of gases, dust, and fume, very acute

and deleterious results may be produced under some conditions while other conditions may allow such rapid diffusion and dispersion of the smoke that no "smoke troubles" will result.

In this report on the conditions in and around the Selby smelter and the so-called Selby "smoke zone" the principal factors in regard to the emanations from the smelter will be discussed as follows:

1. Nature and quantity of dust, fume, and noxious gases discharged from the smelter.
2. Relative geographical positions of the smelter and the "smoke zone."
3. Topography of the smoke zone and the surrounding country.
4. General wind conditions.

NATURE AND QUANTITY OF DUST, FUME, AND NOXIOUS GASES DISCHARGED FROM THE SMELTER.

The Selby smelter is essentially a lead smelter. Its function is the reduction, recovery, and refinement of lead from a variety of ores and mill products received from various points in the Western States. As most of these ores contain gold and silver, these precious metals also are recovered and refined. Besides refining the gold and silver recovered from the ores and concentrates the plant receives from outside sources a considerable amount of impure bullion and high-grade gold and silver concentrates. Several of the ores received at the plant contain small amounts of copper. This copper is made into the commercial copper sulphate "bluestone." The products of the smelter are refined gold, refined silver, lead bars, white lead lead shot, and bluestone.

CLASSIFICATION OF MATERIAL TREATED.

The ores received for treatment may be classed under four heads

1. Direct smelting ores:
   (*a*) Siliceous ores.
   (*b*) Oxidized lead ores.
2. California iron sulphide ores:
   (*a*) Raw sulphide ores.
   (*b*) Preroasted ores.
3. High-grade gold and silver concentrates and lead-bearing iron sulphide ores.
4. Products from lead concentrators:
   (*a*) Concentrates.
   (*b*) Middlings.
   (*c*) Slimes.

The ores of the first class contain very little sulphur and for the most part are treated directly in the blast furnaces.

The California sulphurets (2, *a*) contain about 40 per cent sulphur. Prior to 1913 there was received at the smelter a considerable tonnage of these raw sulphides. At the present time these raw sulphides are first roasted at an acid plant of the General Chemical Co., where about 95 per cent of the sulphur is eliminated from the ore and made into sulphuric acid. The roasted product (2, *b*) contains about 2 to 2.5 per cent sulphur when received at the Selby smelter.

The third class consists of a variety of mill concentrates containing gold and silver from Nevada and California. In this class are also included the sulphide ores that carry considerable lead. Ores of this class are not desired in the manufacture of sulphuric acid because of their relatively low sulphur content (between 10 and 30 per cent) and the possibility of high metal losses resulting from their treatment in the acid plant.

The fourth class comprises all the concentrated lead products received at the smelter. These are chiefly from the Coeur d'Alene district, Idaho, and include all the valuable mill products, concentrates, middlings, and slimes. They furnish the bulk of the lead supply to the plant.

METALLURGICAL FURNACES OPERATED AT THE SELBY SMELTER AND THEIR GASEOUS AND SOLID PRODUCTS.

The metallurgical furnaces operated at the Selby smelter may be classified as follows:

1. Roasting department:
   - Dwight & Lloyd sintering machines.
   - Ropp straight-line roaster.
2. Smelting department:
   - Blast furnaces.
3. Lead refinery:
   - Softening furnaces.
   - Desilverizing kettles.
   - Refining furnaces.
   - Merchant kettles.
4. Gold and silver refinery:
   - Retorts and condensers.
   - Cupelling furnaces.
   - Parting kettles.
   - Melting furnaces.

ROASTING DEPARTMENT.

Before smelting the material classed under 2, 3, and 4—that is, the sulphides and concentrates—it is necessary to eliminate as much of the sulphur as possible. The elimination is effected by a roasting

process, in which the material in pulverulent form is heated in the presence of air to a temperature at which the sulphur will unite with the oxygen of the air to form sulphur dioxide. All of the sulphur dioxide, except a comparatively small portion which is further oxidized to sulphur trioxide, passes off from the charge as a gas.

For many years prior to 1912 most of the roasting at the Selby plant was carried on in Ropp straight-line furnaces. These roasters were built of brick, of the flat-hearth reverberatory type, and heated by oil fire. The charge was dropped in at one end of the furnace and slowly moved to the other by mechanically operated rabbles or plows. In moving the material through the furnace the rabbles turned it over frequently and effected the necessary exposure of the particles to the heated air passing through the furnace. This turning over by the rabbles produced a certain amount of flue dust, which was carried out of the furnace by the air and gas currents into the flue and stack. A considerable portion of the dust escaped into the atmosphere, the remainder settling in the flues. The temperature in the furnace was sufficiently high to cause oxidation and volatilization of some of the metals, especially lead and arsenic. These were carried out of the furnaces, condensation to fume taking place either before or after leaving the furnaces. Thus the Ropp roaster was a source of sulphur dioxide gas, sulphur trioxide fume, flue dust, and fumes of volatilized metallic compounds.

During the last three years the practice of roasting in the Ropp roasters has been gradually superseded by that of roasting on the Dwight & Lloyd sintering machines. There now remains only one Ropp roaster, and this is operated only for special purposes. Not only is the operation carried on at a lesser expense by use of the sintering machines, but the product from the roast is sintered, and therefore is in much better physical condition for the subsequent smelting operation.

DWIGHT & LLOYD SINTERING MACHINE.

The Dwight & Lloyd sintering machine (fig. 5) consists essentially of a train of cast-iron or cast-steel pallets in the form of an endless conveyor, moved by suitable gears and sprocket wheels. Each pallet is 42 inches wide by 24 inches long and 10 inches deep. The bottom of each pallet consists of perforated or slotted grates. Beneath the horizontal portion of this endless pallet conveyor are two sheet-iron "wind boxes," which are connected by suitable sheet-iron pipes to a Sirocco vacuum fan. The sides of the wind boxes are bolted at the tops to iron castings which form the bearing surfaces for the pallets as they pass over them, thus making an air-tight joint. The pallets are each provided with four wheels, which engage on tracks for the travel of the pallets on the under side of the endless circuit.

The ore or charge is fed, in an even layer, onto the pallets just as they come to a horizontal position. As they are pushed forward to a point above the first wind box, the ore is subjected to an oil flame under a heated muffle, and the sulphur of the charge on its top surface is ignited. The combustion is maintained by the air drawn down through the charge and through the perforations in the grates into the wind boxes, by the down draft created by the fan. The roasting proceeds downward until it meets the grates. During the roast the material on the pallets has become agglomerated or sintered. The sintered product is discharged at the end of the horizontal line of pallets by the tipping and dropping of the pallets as they are pushed forward by those behind.

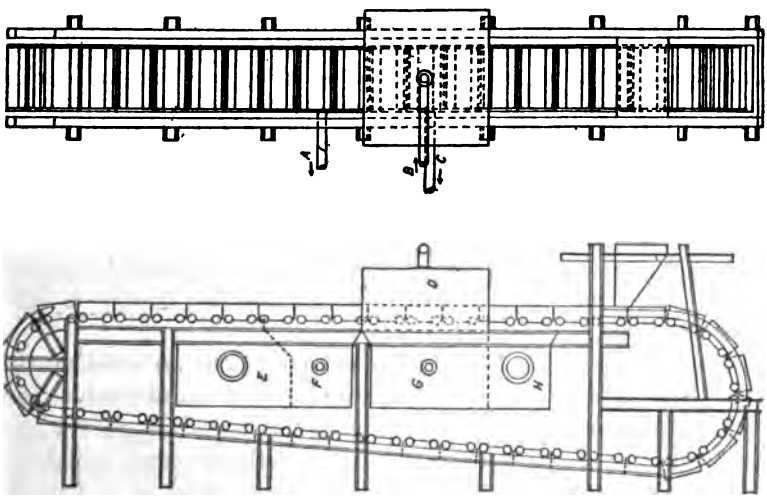


FIGURE 5.—Dwight & Lloyd sintering machine.

The percentage of sulphur eliminated from the charge varies greatly (between 50 and 75 per cent) according to the nature of the charge, the mixture, the ignition, and the speed of travel of the machine. During the year 1913, the average sulphur content of the charge was 13 per cent, and of the sintered product 4.2 per cent; thus the average sulphur elimination was 70 per cent.

At the present time the practice at the Selby smelter is to roast and sinter on the Dwight & Lloyd sintering machines practically all the material classified under 2, 3, and 4 in combination with some fine or crushed siliceous ores, added to give the charge such composition as will produce a good sinter. The preroasted California sulphides (2, *b*) are very fine and are not suited for direct smelting. They therefore form a portion of the charge to the sintering machines. To this mixture are added also certain smelter by-products, such as flue dust and crushed matte.

Not only are the sintering machines a source of sulphur dioxide gas, but a small amount of the fine ore is drawn through the grates by the force of the air currents and carried into the flues as "flue dust." Also the heat of combustion causes the oxidation and volatilization of some of the metals, as lead and arsenic. These are drawn off from the charge as vapor, condensed at lower temperatures, and are present in the flues as "fume."

SMELTING DEPARTMENT.

BLAST FURNACES.

The sintered product from the Dwight & Lloyd machines, or the product from the Ropp roasters, is mixed with the siliceous ores and oxidized lead ores (class 1), with the necessary lime rock for fluxing, and, with coke for fuel, charged into the blast furnaces, and smelted.

The blast furnaces at the Selby smelter are rectangular shaft furnaces 36 inches wide and 144 inches long in cross section at the tuyère line, and about 14 feet high. The lower part of the shaft consists of sheet-iron jackets, above which the shaft is constructed with brick. Air is blown in continuously through circular openings, "tuyères," in the water jackets. The ore, flux, and fuel mixture is fed in at the top of the furnace by hand labor at intervals in order to keep the shaft full to the right height while the charge is smelted and removed at the bottom.

The air blown into the furnace is insufficient to oxidize all the carbon of the coke to carbon dioxide, and considerable carbon monoxide is formed. This reducing gas, rising through the charge in the furnace, reduces some of the lead and the precious metals to the metallic state, the lead collecting the gold and silver as it drips down through the mass. At the point where the coke is incandescent and where the combustion is the most rapid the rest of the lead and precious metals are reduced. At this point the temperature is sufficiently high to cause the formation of a "slag" from the waste portions of the charge. Owing to the reducing atmosphere in the lead blast furnace, very little, if any, of the sulphur present is oxidized to sulphur dioxide. Most of it combines with the copper present in the charge, and with some of the iron and lead to form "matte," which flows out from the furnace with the "slag."

The lead which contains most of the gold and silver, being heavier than either the matte or the slag, settles into the crucible of the furnace, below the point where the slag and matte are tapped out. This lead bullion is removed from the furnace through a separate siphon tap.

The slag and matte are tapped into a settler, where the matte, being heavier than the slag, settles to the bottom and the slag over-

flows into slag pots set on trucks. The waste slag is then tapped out from the slag pots onto the dump. At intervals the matte is tapped out into special cast-iron pans and cooled. The cooled matte is then crushed and roasted. At the present time the greater part of the matte is roasted over the sintering machines, and such will undoubtedly be the practice in the future. Several times during the year it is the practice to accumulate the matte of highest copper content and roast this separately in the Ropp roaster. This matte is then smelted with siliceous ores and flux in a special smelting operation and the grade of the matte raised to about 40 or 45 per cent copper. This high-grade matte is then given a "sulphatizing roast" to convert the sulphur into sulphate for the purpose of leaching and the production of "bluestone."

The lead bullion from the blast furnace is cast into bars and taken to the lead refinery.

As very little of the sulphur charged into the blast furnaces is oxidized in the furnace, the blast-furnace gases are therefore practically free from sulphur dioxide. As a source of sulphur dioxide contamination to the atmosphere the blast-furnace gases are negligible.

However, the blast furnaces do produce a considerable amount of flue dust and fume, which are carried into the flues by the gas currents, and which, if not recovered, are carried out into the atmosphere.

LEAD REFINERY.

SOFTENING FURNACE.

The lead bullion from the blast furnace is melted down slowly in a softening furnace. This furnace is of the reverberatory type, and is heated with oil. In the softening furnace some of the impurities in the lead are removed by oxidation and liquation. The principal impurities are copper, arsenic, and antimony, which on being oxidized in the furnace form a scum or dross on the surface of the melted lead. These are removed by skimming. A very small amount of these impurities may be volatilized to form fume.

DESILVERIZING KETTLE.

From the softening furnace the lead is run into the desilverizing kettle. In this kettle zinc shavings or dust are stirred into the lead while it is kept at the proper temperature by an oil fire. An alloy of zinc, lead, gold, and silver is formed, which appears as a dross. This dross is skimmed off into a Howard press, which serves to eliminate the greater portion of the lead carried mechanically by the dross and to retain the "dry" lead-zinc crust containing the gold and the silver.

REFINING FURNACE.

The desilverized lead is tapped or siphoned from the kettle into a refining furnace, where the zinc that is still in solution is oxidized and removed. The refined lead is then tapped into the "merchant kettle," from which it is cast into the commercial bars.

With the exception of the small amount of arsenic, antimony, or zinc fume that may be evolved from the softening and refining furnaces, there are no emanations from the lead refinery to contaminate the atmosphere. The only gases present are those from the combustion of the oil required to heat the furnaces.

GOLD AND SILVER REFINERY.

RETORTS AND CONDENSERS.

The gold, silver, lead, and zinc alloy crusts from the desilverizing kettle are placed into retort furnaces, where the zinc is oxidized and volatilized. The zinc fumes are condensed as metallic zinc in suitable condensers. This zinc is used again in the desilverizing kettle.

CUPELLING FURNACE.

The residual lead, gold, and silver alloy from the retorts goes to a cupelling furnace. In this furnace the lead is oxidized and skimmed off as lead oxide (litharge). The gold and silver bullion left in the furnace is known as doré. This furnace is a source of lead fume.

PARTING KETTLES.

The gold and silver alloy from the cupelling furnace (doré bullion) is placed in cast-iron kettles and treated with sulphuric acid to dissolve the silver from the gold. In the boiling of this acid, to effect solution of the silver, there are evolved large amounts of sulphur trioxide vapors, which form fume. The fume—fine particles of sulphuric acid—is carried into the flue, and if not recovered passes out into the air. The silver in solution is precipitated in tanks by copper.

MELTING FURNACES.

The gold residue from the parting kettle and the silver precipitates from the tanks are melted down in separate melting furnaces and cast into bars.

Melting furnaces are also used for the melting down of certain high-grade materials received at the plant to remove some of the impurities and to prepare the metals for cupellation or parting.

From the above very brief outline of the work performed in the gold and silver refinery it is evident that there are two fume products that might be discharged into the atmosphere, namely, the lead fume from the cupelling furnaces and the acid fume from the parting kettles.

The preceding brief description of the furnaces and processes employed for the reduction and refining of the lead, silver, and gold from the materials received at the Selby smelter serves to make evident that the principal sources of sulphur dioxide gas, flue dust, and fume are: (1) The roasting furnaces; (2) the blast furnaces; (3) the parting kettles. The minor sources are: (4) Lead softening and refining furnaces; (5) cupelling furnaces.

ELIMINATION OF SULPHUR FROM THE SELBY SMELTER.

Practically all of the sulphur originally present in the ores and concentrates received at the smelter is eliminated in either the roasters or in the blast furnaces.

During the year 1913 the elimination of sulphur by these furnaces was approximately as shown below:

	Per cent.
(*a*) From roasters:	
Sintering machine gases	63
Ropp roaster gases—	
From ore	14
From matte	14
(*b*) From blast furnaces:	
In blast-furnace gases	3
In blast-furnace slag	6

Under the present method of operation, that is, without the use of the Ropp roaster, over 90 per cent of the total sulphur is being eliminated in the sintering-machine gases and 3 per cent in the blast-furnace gases.

During the years January 1, 1910, to May 15, 1914, the sulphur eliminated from the plant in the roaster gases was as shown in the following diagrams:

Figure 1 shows the average daily sulphur output for each month during the period January 1, 1910, to May 15, 1914.

Plate VIII shows the daily output between March 15, 1913, and May 15, 1914.

Table 1, below, gives the average daily output per year, with the maximum for 1910, 1911, 1912, 1913, and January 1 to May 15, 1914.

TABLE 1.—*Sulphur eliminated in roaster gases.*

Year.	Sulphur eliminated.	
	Average.	Maximum.
	Tons per day.	*Tons per day.*
1910	24.9	53.5
1911	25.5	42.9
1912	26.7	41.4
1913	24.4	42.8
1914	28.3	44.6

A small percentage of this sulphur may have been eliminated elemental unoxidized sulphur, especially during the time that California sulphurets were being treated on the sintering machi However, the average amount of sulphur so eliminated is so that it may be disregarded in this discussion, and all of the sulp considered to have been oxidized to dioxide or trioxide.

The relative amounts of sulphur dioxide or trioxide produce the roasting furnaces are variable and depend largely upon charge and the operating conditions.

In the Ropp roasters a considerable amount of sulphur trioxi produced, especially when roasting matte. On the Dwight & L sintering machines, the conversion to sulphur trioxide is only sli Under the charge and operating conditions existing during the in tigations for the commission, the relative amounts of SO_2 and SO_3 found in the gases from the furnaces were as follows:

TABLE 2.—*Relative quantities of sulphur dioxide and sulphur trioxide in roaster ga Average data for October and November, 1913.*

Roaster.	Place of sampling.	Quantity of SO_2 per cubic meter at 0° C. and 760 mm.	Quantity of SO_3 per cubic meter at 0° C. and 760 mm.	Rat SO_2 t by we
		Grams.	*Grams.*	
Single sintering machine	Stack	17.16	0–0.50	
Ropp roaster on ore	Flue	17.80	1.20	
Ropp roaster on matte	Stack	1.14	.45	

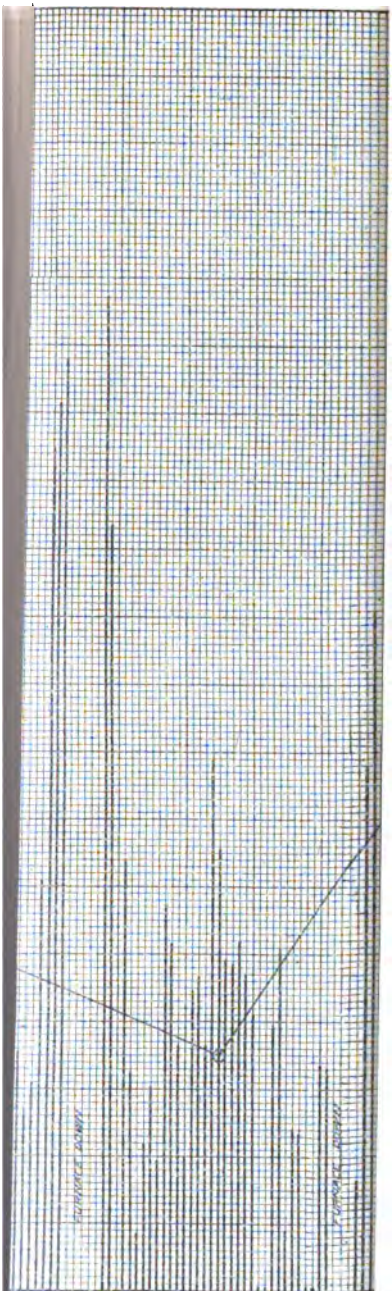
The following, Table 3, gives the percentage of sulphur diox present and the volume of the gases discharged from the roas stack during the days on which tests were made in October November, 1913:

TABLE 3.—*Roaster-stack data—Averages for October and November, 1913.*

Number of Dwight & Lloyd machines.	Number of Ropp roasters on matte.	Number of Ropp roasters on ore.	Temperature of gases.	Volume of gases at 0° and 760 mm.	Average proportion of SO_2, by volume.
			°C.	*Cubic feet per minute.*	*Per cent.*
1	0	0	55	24,000	0.60
1	1	0	120	32,000	.70
2	1	0	155	35,000	1.30
2	0	1	160	35,000	1.60
0	[a]1	0	110	30,000	.10

[a] Sulphatizing roast, matte roasted for "bluestone."

In May, 1914, when the gases from the sintering machines were being filtered through the bag house the average stack data obtained were as given in Table 4.



1913, TO MAY 15, 1914.

TABLE 4.—*Roaster-stack data—Averages for May, 1914.*

Number of furnaces in operation.			Temperature of gases.	Volume of gases at 0° C. and 760 mm.	Average proportion of SO_2 by volume.
Dwight & Lloyd machines.	Ropp roasters on matte.	Ropp roasters on ore.			
			°C.	*Cubic feet. per minute.*	*Per cent.*
3	0	1	130	40,000	1.50
3	0	0	105	24,000	1.70
2	0	0	90	20,000	1.40
1	0	0	70	18,000	.75

These measurements were made at a point about 60 feet above the base of the stack. The sampling platform is shown in Plate V, *B*.

SULPHUR DIOXIDE IN BLAST-FURNACE GASES.

Samples were taken of the blast-furnace gases as they passed into the bag house. These samples averaged 0.04 per cent SO_2 or 400 parts SO_2 per million by volume. No measurements of the volume of the blast-furnace gases were made.

RECOVERY OF FLUE DUST AND FUME FROM THE BLAST-FURNACE GASES.

During the whole operating period of the plant prior to 1908 the fume and a considerable portion of the flue dust produced by the blast furnaces were allowed to escape into the atmosphere. It is true that these products were conducted through some length of flue system. By this practice only the coarser particles of dust were settled out. As the lead-flume and flue-dust losses from the furnaces during those years were high, it is safe to assume that a comparatively large tonnage of this fume and dust was discharged into the air before the installation of the bag house in March, 1908.

CONSTRUCTION OF BAG HOUSE.

Plate V, *C*, shows the outside view of the blast-furnace bag house taken from the west side. This bag house is built of reinforced concrete and is approximately 125 feet long, 90 feet wide, and 68 feet high. Fifteen feet above the ground is a sheet-iron floor covered with concrete. This floor divides the bag house into two chambers, an upper or bag chamber, and a lower or dust chamber. In the floor are 18-inch holes provided with clay-tiling thimbles. Over these thimbles are fitted the lower ends of bags, which are suspended from rods extending across the top of the chamber. In the bag house are 1,920 woolen bags 18 inches in diameter, 30 feet long, with an effective length of about 28½ feet. The bag house is divided into eight compartments by seven partition walls.

OPERATION OF BAG HOUSE.

The gases and fumes driven off from the blast furnaces are drawn through flues by a 12-foot fan, and driven into the bag house below the thimble floor. They are then forced up through the bags. At the temperature of the bag house, less than 230° F., all the metallic fumes are in the solid state. In passing through the bags all of the solids as dust and fume are filtered out; only the gases pass through. These filtered gases are conducted to the 180-foot steel stack (Pl. IV, *A*), from which they are discharged into the atmosphere. Thus the gases passing out of the stack are oxygen, nitrogen, carbon dioxide, and a small percentage of sulphide dioxide and carbon monoxide. As stated above, the sulphur dioxide content of these gases is about 0.04 per cent.

The bags are shaken at intervals by mechanical shakers and the dust adhering to them drops into the dust chamber below. The dust and fume collected contains about 50 per cent lead and 20 per cent arsenic. Analyses of dust samples taken in the months of April to July, 1914, were made by Mr. J. R. Marston, with results as follows:

Analyses of fume and dust from blast-furnace bag house.

Month.	Silica.	Iron.	Sulphur.	Arsenic.	Lead.	Cadmium.	Antimony.
1914.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
April	0.5	0.6	4.5	19.9	49.0	4.0	0.4
May	.5	.2	3.5	19.6	49.0	3.7	.4
June	.4	.5	6.6	11.5	58.2	3.5	.4
July	.6	.7	7.8	4.6	70.8	2.0	.4

Whenever there is an accumulation of this dust in a compartment the material is burned "in situ" by igniting it with oil-saturated waste. In the combustion of this fume there is generated sufficient heat to volatilize some of the compounds, especially the arsenical ones. These are drawn off by a special fan and refiltered in a special compartment of the house. The product of this combustion of the fume is a loosely sintered mass which is resmelted.

Since the installation of the bag house in March, 1908, the solid particles and fume from the blast furnaces have been discharged into the air only at rare intervals and then for brief periods. For a short period each day, about 10 minutes, when the bags are being cleaned, the dust and fume are discharged into the air. Occasionally a bag will tear out or drop from its wire, in which case a small amount of dust and fume will escape until the bag can be replaced.

RECOVERY OF FUMES FROM THE REFINERY.

In the discussion of the emanations from the lead softening and refining furnace and the cupelling furnace, it was pointed out that from each a small amount of fume was produced. As these fumes are now filtered through the blast-furnace bag house, they do not now constitute a source of atmospheric contamination. At the present time it is the practice to put all the gases from the oil fires used to heat these furnaces and the melting furnaces through this bag house. Thus all the emanations from the refining furnaces, except from the parting kettles, are handled in the blast-furnace bag house.

Prior to 1909 the dense white fumes of sulphur trioxide, or the sulphuric acid mist, from the parting kettles were allowed to escape directly into the air. They could not be filtered through bags because of the corrosive action of the acid on the bags. In 1909 the Cottrell electrical precipitation process was installed for the recovery of these fumes. The fumes from the parting kettles are now conducted into a lead-lined flue 4 by 4 feet, in which are placed vertical lead plates 4 inches wide and 4 feet long, alternating with suspended lead-covered iron rods provided with mica points. A difference of electrical potential of 17,000 volts is maintained between the electrodes. As the fumes pass through this electrical field they are electrified and drawn to the plate electrode where they are precipitated. The potential is obtained by transforming an alternating 460-volt, 60-cycle current to 17,000 volts, passing the current through a rectifier, which gives at the electrodes an intermittent direct current of about the same voltage. This apparatus has been highly efficient in removing the fumes evolved from the parting kettles, and they do not now furnish a source of contamination to the atmosphere.

RECOVERY OF FLUE DUST AND FUMES FROM THE ROASTER AND THE SINTERING MACHINES.

When the roasting operations of the plant were carried out in the Ropp roasters, there was no possibility of filtering the gases through bags without the employment of a large amount of a neutralizing agent for the neutralization of the sulphur trioxide or the acid present. Instead of working along these lines, the Selby management, in 1909 and 1910, tried to effect a precipitation of this dust and fume by the application of the Cottrell process.

An experimental flue, 6 feet 6 inches by 30 feet long, was equipped to handle about 50,000 cubic feet of gas per minute. The flue contained 38 rows of 16 plates, each 6 feet long and 4 inches wide. These plates were alternated with the several types of discharge electrodes used. Considerable difficulty was experienced in carrying on a continuous operation of the process, due to the muddy character of the

material collected. The installation of an operating unit was never carried out. Thus until April of this year the fume and dust from the roasters were discharged into the atmosphere (see Pl. IV *B*), the only recovery made being what was obtained by settling in the flue system.

With the substitution of the sintering machines for the Ropp roasters, the possibility of filtering the roaster gases through bags became greater. During 1913 several investigations were made by the company to determine the acid content of the gases from the sintering machines. It was found that the conditions were favorable for the operation of a bag house. There was present very little elemental sulphur, which had been the cause of trouble at other plants where attempts had been made to filter sintering-machine gases. Furthermore, owing to the presence of considerable zinc and lead on the charge, the sulphur trioxide formed in the roast was to a great extent neutralized by fumes of those metals.

When requested by the Selby Smelter Commission to remove the fume and dust from the roaster gases, the Selby management constructed a bag house instead of installing the Cottrell process for this purpose. It was recognized that, if in the future it was necessary to operate the Ropp roaster during the "closed season," it would be necessary to neutralize the gases from that furnace to permit of their being filtered or treat them by the Cottrell process.

The bag house for the roaster gases (Pl. IX, *A*) is 45 feet long, 30 feet wide, and 50 feet high. It is built of reinforced concrete and is divided into four sections by partition walls. Each section contains 75 bags, 30 feet long and 18 inches in diameter. Beneath the thimble floor are constructed sheet-iron hoppers into which the collected dust is dropped when the bags are shaken. The bottoms of these hoppers are V shaped, and are provided with gates for the removal of the dust into cars which can be pushed in on tracks below.

The gases and fume drawn off from the sintering machines by the Sirocco fans are discharged into a brick flue. From this brick flue they are drawn by a 5-foot Sirocco-type fan, capacity of about 30,000 cubic feet per minute, around a system of steel balloon flues, in which some of the coarse dust particles are settled by gravity, and the gases are cooled. The gases are then forced through the bags. After passing through the bags, the filtered gases from the top of the bag house are conducted by a steel flue to the brick stack (Pl. IV, *C*), from the top of which, 160 feet above the ground, they are discharged into the air.

The temperature of the bag house is about 200° F., at which temperature all of the volatilized lead, arsenic, and other metallic compounds are in the fume state and are effectively removed.

A. BAG HOUSE FOR ROASTER GASES.

B. GENERAL VIEW OF SMELTER STACKS, SEPTEMBER, 1914.

C. VIEW TOWARD WEST ALONG THE STRAITS FROM STATION 2.

Due to a rather inefficient shaking device used for cleaning the bags, some little trouble was experienced at first in maintaining a continuous operation of this bag house. Being improperly cleaned the bags offered such a resistance to the passage of the gases that the bag-house fan could not drive through them the gases coming from the individual fans of the sintering machines. However, this difficulty has been successfully overcome by a more efficient shaking device and by more frequent shakings. Since the first of May, 1914, this bag house has been operating very satisfactorily.

A good record of the dust and fume that was discharged from the Selby roaster stack during the years that the plant has been in operation is not to be had. The amount discharged per day was undoubtedly very variable, depending upon charge and operating conditions

Analyses made by Mr. Marston of the monthly samples taken from the bag-house dust are given below.

Results of analyses of dust from sintering-machine bag house.

Month.	Silica.	Iron.	Sulphur.	Arsenic.	Lead.	Zinc.	Antimony.
1914.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
April	0.5	0.5	7.4	2.3	70.4	0.2	0.3
May	.4	.6	5.8	9.7	64.4	.3	.2
June	.9	2.1	7.2	4.8	66.6	1.4	.2
July	.5	1.1	7.0	4.9	67.3	1.2	.1

During May and June the amount of dust recovered in the bag house varied from 3,000 pounds to 5,000 pounds, averaging about 4,000 pounds. At times there was a very small amount of visible smoke, showing that some fume was escaping.

On May 5 and 6, and again on the 16th, tests were made by chemists of the commission to determine the amount of lead and arsenic that was still being discharged from the roaster stack. On May 5 and 6 there was a slight amount of visible smoke escaping from the stack. Due to a mistake in placing a damper in the flue, some of the unfiltered gases were allowed to pass directly into the stack during the time that about 7 per cent of the total sample was taken on May 16.

Measured volumes of the gas were drawn out from several points in the cross section of the stack at a point about 60 feet above the ground. These volumes were filtered through a Brady filter and the solid material collected in the filter analyzed for lead and arsenic. On each of these days there were three sintering machines in operation. The results, given below, show that even with a slight visible smoke from the bag house, the efficiency of the bags is about 96 per cent. With the better results obtained since the improvement in the shaking device, the efficiency has been greater.

TABLE 5.—*Results of tests to determine quantity of lead and arsenic being discharged from the roaster stack after the installation of the sintering-machine bag house.*

Item.	May 5–6.	May 16.
Data regarding gases in stack:		
Temperature, °C	95	80
Velocity, feet per minute	520	525
Volume, cubic feet per minute at flue temperature	32,800	33,000
Volume, cubic feet per minute at 0° C. and 760 mm	24,500	25,500
Volume sample, cubic feet at 0° C. and 760 mm	19.52	10.75
Lead present—		
In sample, grams	0.024	0.015
Per cubic foot, grams	0.00123	0.0014
Arsenic present—		
In sample, grams	0.0020	0.0015
Per cubic foot, grams	0.00010	0.00014
Rate of discharge of fume:		
Lead per minute, pounds	0.067	0.078
Lead per 24 hours, pounds	96	113
Arsenic per minute, pounds	0.0054	0.0079
Arsenic per 24 hours, pounds	8	11

From the foregoing discussion it is evident that the only smelter emanations that have been contaminating the atmosphere in the vicinity of the Selby plant during the investigation of the Selby Smelter Commission have been the dust and fumes from the roasters during part of the period and the sulphur dioxide from the roasters during the whole period.

RELATIVE GEOGRAPHICAL POSITIONS OF THE SMELTER AND THE "SMOKE ZONE."

The Selby smelter is situated near Vallejo Junction in Contra Costa County, at the western end and on the south shore of the Carquinez Straits, where the straits open out into San Pablo Bay.

The city of Benicia is situated in Solano County, at the other end of the straits, in a line almost due east, and about 4½ miles from the smelter. The general direction of the straits is east and west.

As indicated on Plates VI, VII, and XXXVIII, the territory included in the "smoke zone" of the Selby smelter lies north of the straits and south of the highway between the cities of Benicia and Vallejo, east from Vallejo to near the turn of the road at B, at the Midway House. East of this point, the extreme northern line is rather indefinite but may be taken as following a northeasterly line from B to the Sulphur Springs Valley Creek, and following the creek down to Suisun Bay.

The nearest point of this district to the smelter is a point of land known locally as "Dead Man's Point," this point being 1 mile distant from Selby. The most remote point where smoke damage or nuisance was claimed was about 6 miles distant from the smelter.

TOPOGRAPHY OF THE SMOKE ZONE AND THE SURROUNDING COUNTRY.

Rising abruptly from the water on both sides of the straits are fairly high hills or bluffs, which form a natural air channel or chute between the Selby smelter and Benicia.

Except for a single canyon south from Crockett, 1 mile east of the smelter, the bluffs on the south side are practically continuous and average between 200 and 400 feet in height above the straits.

On the north side of the straits the line of bluffs nearest the water is not so high, and has receded for short distances at Dos Reis Cove, at Elliot Cove, at Glen Cove, and for a considerable distance at Southampton Bay. In the recession at Southampton Bay is a considerable area of marsh land. Between Glen Cove and Southampton Bay is a high promontory known as Dillon Point, at the top of which is located the North Tower of the Pacific Gas & Electric Co.'s power line.

East of Southampton Bay the hills continue, their crests running in a general southeast or easterly direction. Between these hills and the straits, occupying a strip of land about 3 miles in length, and varying between 100 yards and 1 mile in width, are situated the residential and business portions of the city of Benicia.

Except for the narrow strip included in the Benicia city limits, the country is very hilly and is devoted to agriculture and stock raising.

With such topography it is evident that when the wind is from the west the smoke from the Selby smelter is blown along the straits past Dillon Point directly toward and over Benicia. Under a wind slightly south of west, the smoke is blown across the straits toward Elliot and Glen Cove and over the agricultural district. When there is only a slight drift of air from these directions the smoke tends to drift along the straits and settle back up into the coves and depressions in the bluffs on the north.

Between the promontory at Dillon Point where the north tower is located and the hill directly north is a slight depression which serves as a sort of channel for the air currents that swing in close to the north shore of the straits.

GENERAL WIND CONDITIONS IN THE SELBY SMOKE ZONE FOR A PERIOD OF YEARS.

During the last few years a very complete record of the direction and velocity of the wind has been kept at the Selby smelter. The observations were made six times every 24 hours, at 3 a. m., 7 a. m., 11 a. m., 3 p. m., 7 p. m., and 11 p. m., by certain men who were on duty at those hours. Believing that those wind records are suffi-

ciently accurate, and as they were found to check fairly well with the observations of the field men of the commission during the time the field work was going on, the data from these records have been used in the discussion of the general wind conditions of the "smoke zone."

The data of 1911, 1912, and 1913 are tabulated in the following table, showing the percentage of the total number of observations each month, made when the wind was in each of the several directions indicated. These data are represented graphically in figures 2, 3, and 4.

TABLE 6.—*Directions of wind—Percentages of total records by months.*

Month.	North.	North-east.	East.	South-east.	South.	South-west.[a]	West.	North-west.	Calm.
1911.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*
January	.....	1.1	32.3	1.1	7.5	26.3	4.3	.....	27.4
February	1.2	2.4	22.0	1.2	8.3	20.2	12.5	5.4	26.8
March	.....	1.0	19.9	.....	6.5	39.8	16.7	1.6	14.5
April	2.2	1.1	.5	.....	3.3	56.8	26.2	.5	9.4
May	1.7	.....	1.1	.....	.6	65.1	24.2	2.8	4.5
June	.....	.....	.....	.....	1.1	93.2	4.0	.....	1.7
July	1.1	.....	.....	.....	.5	89.8	7.5	.....	1.1
August	.....	.....	.....	.....	1.1	92.5	4.8	.....	1.6
September	.....	.....	.....	.....	.....	77.8	12.2	.....	10.0
October	1.1	.5	11.3	1.1	1.1	42.5	17.2	.5	24.7
November	.6	.6	27.8	1.6	.5	27.8	6.7	3.9	30.5
December	3.2	5.9	30.2	.5	2.1	15.1	7.0	5.4	30.6
1912.									
January	.....	2.7	41.9	1.6	5.8	16.1	2.2	.....	29.7
February	7.5	1.1	10.3	.....	.5	35.7	12.1	9.2	23.6
March	2.7	2.2	11.5	2.2	3.3	49.7	13.1	1.6	13.7
April	.....	.....	1.1	.5	2.9	58.1	25.9	6.3	5.2
May	.....	.....	.5	.....	2.7	78.8	8.2	.5	9.3
June	1.2	.....	3.8	.6	2.5	72.2	10.2	.6	8.9
July	.....	.....	.....	.....	.....	86.6	11.8	.....	1.6
August	1.1	.....	.....	.....	.....	83.9	11.8	.5	2.7
September	.....	.5	.5	.....	3.9	66.7	17.2	.5	10.7
October	1.6	6.5	1.6	1.6	1.1	42.4	12.4	1.6	31.2
November	.....	5.5	23.4	5.0	5.5	22.9	9.4	1.1	27.2
December	3.7	6.5	23.7	1.6	2.1	26.4	5.4	1.6	29.0
1913.									
January	4.5	3.9	22.9	6.7	7.3	29.1	3.3	.....	22.3
February	5.3	4.2	14.9	3.6	2.4	28.6	17.8	2.4	20.8
March	1.6	1.1	7.0	1.1	5.4	38.7	30.1	3.2	11.8
April	.5	1.6	2.2	.5	3.3	42.3	26.7	11.2	11.7
May	.5	.....	.5	.....	1.1	59.1	34.4	2.2	2.2
June	.....	.....	.....	.....	.....	67.9	30.5	1.1	.5
July	.....	.....	.5	.....	.....	76.9	17.2	1.6	3.8
August	.....	.5	.5	1.1	.....	60.8	28.5	.5	8.1
September	1.1	1.6	.....	.5	.....	57.6	17.9	.5	20.8
October	1.6	2.7	2.7	.....	1.6	44.2	6.8	3.2	37.2
November	1.1	3.3	14.4	3.3	7.8	31.7	12.8	3.9	21.7
December	.....	11.3	37.6	4.3	7.5	18.3	.5	1.1	19.4

[a] A southwest wind at the smelter usually means a wind almost west or only slightly south of west along the straits.

From these figures it is evident that during the months April to November the wind is from the west or southwest about 85 per cent of the time, and during several months of that period may be from that general direction 98 per cent of the time. During the other months of the year the wind is more variable and often calm. Even during the winter months the wind does blow from the west part of the time.

Thus during the months April to November, the smoke generally is blown or drifted toward Benicia or the agricultural district west or northwest of the city.

A study of the velocity records shows that during the April-November period (the period of the "trade winds") the general condition is a calm or very slight west wind during the early morning hours. During the morning the wind freshens and by noon it has attained a velocity of about 12 miles per hour. In the late evening the breeze gradually dies down.

SUMMARY.

On account of the geographical position of the Selby smelter and the "smoke zone," the topography of the surrounding and intervening country, and the general wind conditions existing during the greater part of the year, the Selby smelter is situated very unfortunately in so far as "smoke troubles" are concerned. To a degree not usual around most smelters, all of the natural conditions tend to retard the dispersion and diffusion of the dust, fume, and gases that might emanate from the smelter, and make them more concentrated over the "smoke zone" than would be expected. We must expect, therefore, that the elimination of a comparatively small amount of sulphur dioxide gas, dust, and fume from the Selby smelter would be more serious during eight months of the year than a larger amount emanating from smelters situated in more favorable locations.

INVESTIGATIONS TO DETERMINE THE EXTENT OF THE CONTAMINATION OF THE ATMOSPHERE IN THE SELBY "SMOKE ZONE" BY THE SMELTER EMANATIONS.

By A. E. Wells.

INVESTIGATION OF THE SULPHUR DIOXIDE CONTENT OF THE ATMOSPHERE IN THE SELBY "SMOKE ZONE."

A preliminary review of the conditions in the "smoke zone" of the Selby smelter indicated that here, as in practically all "smoke zones," it would be necessary to make an extended and detailed study of the sulphur dioxide content and other elements of the atmosphere before any conclusions could be reached concerning the extent of contamination caused by the smoke from the Selby smelter. Such a detailed study required the determination of the sulphur dioxide content at many points under all possible atmospheric and wind conditions. This study further necessitated a determination of the amount of contamination when the wind was blowing the smoke directly from the smelter over the "smoke zone" during periods of maximum and minimum discharge of sulphur dioxide. In order to determine the variation in the sulphur dioxide content, as well as the maximum contamination under the several conditions where slight variations produce great changes in the gas concentration, it was found necessary to take a great number of "instantaneous" samples. For the purpose of checking these "instantaneous" samples "continuous" samples were taken. The methods used for the "instantaneous" sampling, "continuous" sampling, and the methods of analysis of these samples are described in another section of this report.

As an aid in collecting the desired data from all parts of the "smoke zone" it was decided to equip a portable laboratory which could be moved from point to point and so stay in the smoke stream. For this purpose an automobile was equipped with the necessary analytical apparatus, cabinets, etc., as described on pp. 210–212. This automobile laboratory was equipped in San Francisco during August, 1913, and was used during the early part of September to make tests in and around San Francisco. The automobile laboratory arrived in Benicia on September 17, and until October 8 was the only apparatus used for making sulphur dioxide determinations in that district. Guided by the results obtained during that time, by personal observation;

concerning the general direction of the smoke stream, and by the statements made by many of the people in the district concerning the places where the smoke was most often observed, it was decided to establish and equip two fixed stations for analytical work to supplement the data obtained with the portable laboratory.

One of the stations was established at the point *1*, Plate VI, near the old mill by J. G. Fisher's house, on a low promontory in the western part of the city of Benicia. This point was in a line directly east of the smelter and 4 miles distant. A vacant house, situated about 200 feet back from and 30 feet above the water's edge, was used as a laboratory. All apparatus for the "instantaneous" samples and their analyses and for taking "continuous" samples was set up in the southwest room. From this station could be had an excellent view (Pl. X, *A*) of the straits in the direction of the smelter, which made general observations at this station of much value.

The Selby roaster stack itself could not be seen, but, previous to the installation of the bag house, the smoke from the stack could be seen very soon after it was discharged.

The "instantaneous" samples were taken either on the front porch or in the yard about 40 feet away from the house. The inlet tube to the absorption train for continuous samples extended through a window to the outside of the house. As the windows were kept open, there was a good circulation of air around the inlet, so that the air drawn in was a good sample.

The location of this station was such that the results obtained here represented the maximum contamination in the city of Benicia due to smoke coming from the west or from the Selby smelter. The greater portion of the residence section and the whole of the business section of Benicia are situated east or southeast of this station, and any smoke coming from the west, almost without exception, reaches this point first.

Because of its relative proximity to the smelter, the topography of the surrounding country, and the wind conditions existing during the period of the trade winds it was decided to locate a station at the point marked "station 2" (see Pl. VI) on the land leased by M. White, on Dillon Point near the North Tower of the Pacific Gas & Electric Co. Between the hill on which the tower is located and the hill directly north is a rather slight depression which serves as a natural funnel or draw, similar, though to a less degree, to that produced by the bluffs on the two sides of the straits. Thus, when the wind is very light and from the west or slightly south of west the smoke of the smelter drifts toward this point and tends to settle in this depression. During the time between September 18 and October 8 the smoke was found to be present at this place more often

and in greater strength than at any other point in the "smoke zone." Thus this point was selected as being the one where the maximum contamination of the atmosphere in the "smoke zone" of the Selby smelter would be found. This station was about 2½ miles from the smelter, in a direction about 8° north of east. From this station an excellent view of the straits west of Dillon Point and the top of the smelter roaster stack could be had. (See Pl. IX, *C.*)

During the time the smoke was visible—that is, before the installation of the roaster bag house—the smoke could be seen issuing from this stack. When the wind was from the south, southwest, west, or northwest it could be followed by the eye for a considerable distance.

GENERAL SUMMARY REGARDING ALL "INSTANTANEOUS" SAMPLES IN SELBY "SMOKE ZONE."

The total number of "instantaneous" samples taken in the Selby "smoke zone" was 4,862, of which 1,955, or 40.2 per cent, were taken at the Benicia station (station 1), 1,674, or 34.4 per cent, were taken at the station on White's ranch (station 2), and 1,233, or 25.4 per cent, were taken with the automobile equipment at a great many points. This sampling and the analyses extended through six months of active field work. Table 7 shows the distribution of these samples.

TABLE 7.—*Time of taking and number of "instantaneous" samples taken in the Selby "smoke zone."*

Month.	Number of tests.	Proportion of total.
1913.		*Per cent.*
September	232	4.8
October	1,216	25.0
November	1,069	22.0
1914.		
March	386	7.9
April	1,216	25.0
May	743	15.3
Total	4,862	.....

Samples were taken between the hours of 4.00 a. m. and 6.00 p. m., as shown below:

Hours at which "instantaneous" samples were taken.

Hours	Number of samples.	Proportion of total.
		Per cent.
4 a. m. to 8 a. m.	179	3.7
8 a. m. to 12 m.	2,140	44.0
12 m. to 6 p. m.	2,543	52.3
Total	4,862	.....

A. VIEW TOWARD WEST ALONG THE STRAITS FROM STATION 1.

B. APPARATUS FOR GETTING KNOWN MIXTURES OF SULPHUR DIOXIDE AND AIR.

Of the total 4,862 samples 3,663 (75.35 per cent) were found to contain less sulphur dioxide than the equivalent of one-tenth of a cubic centimeter of N/500 iodine solution, which was the limit of the sensibility of the analytical method used. In calculating the average sulphur dioxide content of the 4,862 samples, these samples were assumed to contain one-half the smallest quantity that could be determined by titration, as stated above. The average analysis of the 4,862 samples, calculating the 3,663 in the above manner, was 0.22 part SO_2 per million parts of air. Were these 3,663 samples assumed to contain no sulphur dioxide at all, the average analysis of the 4,862 samples would be 0.15 part SO_2 per million of air. In the following table is shown the number of samples containing sulphur dioxide between certain limits:

TABLE 8.—*Number of "instantaneous" samples that contained different amounts of SO_2 content.*

Limits of concentration (parts of SO_2 per million).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	3,663	75.35
.2 to .4	531	10.91
.4 to .6	322	6.61
.6 to .8	155	3.19
.8 to 1.0	69	1.42
1.0 to 1.5	66	1.37
1.5 to 2.0	35	.72
2.0 to 2.5	12	.25
2.5 to 3.0	3	.06
3.0 to 4.0	2	.04
4.0 to 5.0	2	.04
5.0 to 7.0	2	.04
	4,862	.....

Thus, of the total number of "instantaneous" samples taken in the Selby smoke zone during the months of September, October, and November, 1913, and March, April, and May, 1914, 75.35 per cent contained less than 0.2 part SO_2 per million parts air; 86.26 per cent contained less than 0.4 part SO_2 per million parts air, and 97.46 per cent contained less than 1.0 part SO_2 per million parts air. Only 21 samples, or 0.43 per cent, contained more than 2 parts SO_2, and no sample analyzed more than 7.1 parts SO_2 per million. In order to set forth this vast amount of analytical data in such a manner that the salient features can be studied readily, these results have been separated into two major divisions and the divisions further subdivided, as follows:

Outline of method of presenting data regarding "instantaneous" samples.

A. Determinations made inside city limits of Benicia.
  1. General summary.
  2. Summary of determinations made during definite periods of time.
  3. Summary of determinations made under different wind conditions.
  4. Summary of determinations made within the following limits of areas.
    (*a*) Station 1.
    (*b*) Vallejo-Benicia road, between shipyard and city limits near Carty's.
    (*c*) North of Vallejo-Benicia road, between Burke's saloon and shipyard.
    (*d*) Residential portion of Benicia, east of Burke's saloon, including hills north of K Street and east to arsenal.
    (*e*) Business section of Benicia south of J Street.

B. Determinations made in the agricultural district west or northwest of Benicia, between Benicia and Vallejo.
  1. General summary.
  2. Summary of determinations made during definite periods of time.
  3. Summary of determinations made under different wind conditions.
  4. Summary of determinations made within the following locations:
    (*a*) Station 2.
    (*b*) Coves west of station 2, comprising Glen, Elliott, and Dos Reis Coves.
    (*c*) Vallejo-Benicia road, between city limits and Carquinez cemetery.
    (*d*) Vallejo-Benicia road between Carquinez cemetery and Vallejo city limits.

DETAILED RESULTS OF DETERMINATIONS MADE INSIDE CITY LIMITS OF BENICIA.

GENERAL SUMMARY.

Total number of samples, 2,841.

Average sulphur dioxide content of samples 0.20 part per million parts of air.

Maximum concentration found, 2.4 parts SO_2 per million parts of air.

Range of results—

Range of results of determinations of SO_2 within city limits of Benicia.

Limits of concentration (parts SO_2 per million).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	2,129	75.00
0.2 to 0.4	386	13.56
0.4 to 0.6	197	6.92
0.6 to 0.8	80	2.80
0.8 to 1.0	27	.95
1.0 to 1.5	16	.56
1.5 to 2.0	5	.17
2.0 to 2.5	1	.04
	2,841	100.00

Thus, 75 per cent of the samples contained less than 0.2 part SO_2 per million parts air; 88.56 per cent less than 0.4 part SO_2 per million parts air; and 99.23 per cent contained less than 1.0 part SO_2 per million. Only 1 sample of the 2,841 contained more than 2.0 parts SO_2 per million parts of air.

SUMMARY OF DETERMINATIONS MADE WITHIN DEFINITE TIME PERIODS.

A summary of the determinations made within definite periods of time follows:

Summary of determinations made within definite time periods, city limits of Benicia.

Month or time.	Number of determinations.	Proportion of total.	Parts SO_2 per million parts air.	
			Average.	Maximum.
		Per cent.		
September	85	3.0	0.50	1.70
October	732	25.8	< .20	2.40
November	704	24.8	< .20	1.00
March	180	6.3	< .20	1.00
April	654	23.0	.25	1.00
May	486	17.1	.30	1.25
	2,841	100.0	.....	.....
4 a. m. to 8 a. m.	136	4.8	< .20	.65
8 a. m. to 12 m.	1,300	45.7	.20	1.00
12 m. to 6 p. m.	1,405	49.5	.22	2.40

SUMMARY OF DETERMINATIONS MADE UNDER DIFFERENT WIND CONDITIONS.

A summary of determinations made under different wind conditions follows:

Summary of determinations made under different wind conditions.[a]

Condition of wind.	Number of determinations.	Proportion of total.	Parts SO_2 per million parts air.	
			Average.	Maximum.
		Per cent.		
Slight west wind or calm	577	20.3	0.30	2.40
Moderate or high west wind	836	29.4	.27	1.25
South or southwest wind	405	14.3	< .20	.80
East or southeast wind	398	14.0	< .20	.80
North or northeast wind	173	6.1	< .20	.40
Northwest wind	452	15.9	< .20	.60
	2,841	.....	.....	.....

[a] In segregating the data the local wind conditions as recorded at the place of sampling were used.

SUMMARY OF DETERMINATIONS MADE WITHIN CERTAIN DEFINITE AREAS.

Summary of determinations made within certain definite areas.

Place of taking sample.	Number of samples taken.	Proportion of total.	Parts SO_2 per million parts air.	
			Average.	Maximum.
		Per cent.		
Station 1	1,989	70.1	0.22	2.40
Vallejo-Benicia road between shipyard and city limits	339	11.9	.20	1.25
North of Vallejo-Benicia road, between Burke's saloon and shipyard	89	3.1	.23	1.10
Residential section east of Burke's saloon to arsenal, including hills north of K Street	242	8.5	.20	1.70
Business section of Benicia south of J Street	182	6.4	< .20	1.00
	2,841			

GENERAL DISCUSSION OF THE RESULTS OBTAINED INSIDE THE CITY LIMITS OF BENICIA.

Samples of air taken when the wind was from a direction other than west occasionally contained determinable quantities of sulphur dioxide. The average content of these samples, however, was less than 0.2 part SO_2 per million parts air, and the maximum was 0.8 part SO_2 per million. This value was obtained when the wind was from the east or southeast, and undoubtedly contained SO_2 from the smelter of the Mountain Copper Co. at Martinez.

Samples taken when the wind was from the west generally contained determinable amounts of sulphur dioxide. The highest concentration (2.4 parts SO_2 per million) was found in a sample taken at station 1, when the wind conditions were such that the smoke was drifted over the station with apparently the least amount of diffusion or dispersion. The samples containing more than 1 part SO_2 per million were, with three exceptions, all taken along the water front between the shipyard and the end of G Street. The three exceptions were taken near the Dana place, one-half mile north of the Vallejo-Benecia Road, on September 27.

The samples taken in the residential section east of Burke's saloon and north of G Street all contained less than 1 part SO_2 per million. In the business portion of the town, south of G Street, the smallest concentrations were found.

The highest concentrations were found during the times when there was a very light west wind or an almost calm, causing the Selby smoke to drift in puffs or pockets along the straits directly to Benicia. Under these very unfavorable conditions, the maximum concentration found was 2.4 parts SO_2 per million, and 22 samples of the 577 taken

under these conditions contained more than 1 part SO_2 per million of air.

With a moderate or brisk west wind, the sulphur dioxide was so well diluted by the time the smoke reached Benicia that no high concentrations were found. Even under the maximum sulphur output from the smelter, the highest concentration was not more than 1.25 parts SO_2 per million.

DETERMINATIONS MADE IN AGRICULTURAL DISTRICT WEST AND NORTHWEST OF BENICIA, BETWEEN BENICIA AND VALLEJO.

GENERAL SUMMARY.

Total number of samples, 2,021.

Average sulphur dioxide content of samples 0.24 part SO_2 per million parts air.

Maximum concentration, 7 to 7.1 parts SO_2 per million parts air.

Range of results—

Range of results of determinations of SO_2 in agricultural district west and northwest of Benicia, between Benicia and Vallejo.[a]

Limits of concentration (parts SO_2 per million).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	1,534	75.80
.2 to .4	145	7.20
.4 to .6	125	6.20
.6 to .8	75	3.70
.8 to 1.0	42	2.10
1.0 to 1.5	50	2.50
1.5 to 2.0	30	1.50
2.0 to 2.5	11	.55
2.5 to 3.0	3	.15
3.0 to 4.0	2	.10
4.0 to 5.0	2	.10
5.0 to 6.0	1	.05
6.0 to 7.0	1	.05
	2,021	100.00

[a] Several of the determinations giving results higher than 3 parts SO_2 per million have been multiplied by the factor 1.2 to correct for analytical errors of the original method.

Thus 75.8 per cent of the total number of samples taken in the agricultural district contained less than 0.2 part SO_2 per million parts air; 83 per cent less than 0.4 part SO_2 per million parts air; and 95 per cent of the total number contained less than 1 part SO_2 per million parts air. Twenty samples contained more than 2 parts SO_2 per million. The maximum concentration was 7.1 parts SO_2 per million.

SUMMARY OF DETERMINATIONS MADE WITHIN DIFFERENT TIME PERIODS.

A summary of determinations made within different time periods follows:

Summary of SO_2 determinations made within different time periods.[a]

Month or time.	Number of determinations.	Proportion of total.	Parts SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
September	147	7.3	0.75	3.0
October	484	24.0	.35	7.1
November	365	18.0	< .20	1.8
March	206	10.2	< .20	0.2
April	562	27.8	< .20	1.0
May	257	12.7	.25	3.2
	2,021	100.0	.....	.....
4 a. m. to 8 a. m.	43	2.1	.20	0.6
8 a. m. to 12 m.	840	41.6	.23	7.1
12 m. to 6 p. m.	1,138	56.3	.26	5.5
	2,021	100.0	.....	.....

[a] The samples taken at this point (the agricultural district) during September averaged higher than during the following months. In September the samples were taken only when the smoke from Selby was blown generally to this point.

SUMMARY OF DETERMINATIONS MADE UNDER VARIOUS WIND CONDITIONS.

In segregating data according to the wind conditions existing at the time the samples were taken, the following subdivisions have been used:

1. Slight west wind or almost calm. Smoke drifting or blown gently along lines included in the angle COD, or along line OED. (Pl. VI.)
2. Smoke blown along same lines as above but under strong or moderate wind.
3. Smoke blown along straits or on Contra Costa shore, along lines indicated in angle AOC (Pl. VI). Wind direct from west or slightly north of west.
4. Wind from south or southwest blowing smoke along path of angle EOF (Pl. VI).
5. Wind from southeast or east.
6. Wind from northeast or north.

Summary of results of SO_2 determinations made under various wind conditions.[a]

Condition of wind.	Number of samples.	Proportion of total.	Parts SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
Slightly west. Smoke in path COD or OED.[b]	300	14.9	0.90	7.10
Strong or moderate west. Smoke in path COD or OED.[b]	186	9.2	.45	1.15
Smoke in path COA.[b] West or northwest wind	787	38.9	< .20	.95
South or southwest wind	288	14.3	< .20	1.00
East or southeast	316	15.6	< .20	.20
North or northeast	144	7.1	< .20	< .20
	2,021	100.0	.24	.....

[a] In segregating the data the local wind conditions as recorded at place of sampling were used.
[b] Letters refer to Plate VI.

DETERMINATIONS MADE WITHIN CERTAIN DEFINITE AREAS.

The results of determinations made within certain definite areas were as follows:

Results of SO_2 determinations made within certain definite areas.

Place of sampling.	Number of samples.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
Station 2 at White's	1,773	87.7	0.25	7.10
Coves, west of station 2, Glen, Elliot, and Dos Reis	95	4.7	.20	2.25
Vallejo-Benicia road between city limits and Carquinez cemetery	111	5.5	.27	2.60
Vallejo-Benicia road between Carquinez cemetery and Vallejo city limits	42	2.1	< .20	1.00
	2,121	100.0	.24	7.10

GENERAL DISCUSSION OF RESULTS OBTAINED IN AGRICULTURAL DISTRICT NORTH OR NORTHWEST OF BENICIA.

When the wind was from the east, southeast, north, or northeast, the amount of sulphur dioxide in the atmosphere was not determinable by the method employed for the instantaneous samples.

As was expected, the greatest sulphur dioxide contamination was found during the times that the Selby smoke was blown gently or drifted along the paths COD or OED. (Pl. VI.) Under these conditions the smoke at times became rather dense along the bluffs north of the straits, and the sulphur dioxide concentration of the atmosphere in that portion of the agricultural district averaged 0.90 part SO_2 per million parts of air. On four occasions the sulphur dioxide could be detected by smell, and samples taken during these occasions contained between 3 and 7 parts SO_2 per million parts of air.

The determinations and observations made at station 2 checked the statements made by many of the residents of the district and confirmed our conclusions that this station was located in a place where the greatest contamination in the agricultural district would be found. The sulphur dioxide concentrations found at this point on several occasions were comparatively very high.

These high concentrations were obtained when puffs of smoke drifted along past the station. Only at one time did the concentrations remain high for more than a few minutes at a time, as will be shown later.

In the agricultural district along the road between the Benicia city limits and Carquinez cemetery the concentration was found to be above 1 part SO_2 per million only on one afternoon, September 30, when the right wind condition existed to carry puffs of smoke with about 2 parts SO_2 per million over to the land of Manuel Brazil. Between the Carquinez cemetery and the Vallejo city limits only the slightest traces of SO_2 were ever found.

DETAILED RESULTS OF DETERMINATIONS.

METHOD OF CLASSIFYING DETAILS.

In the following pages the determinations, summarized above, will be segregated according to the location of the sampling point as previously outlined, and the details of each segregation will be discussed rather fully. This detailed discussion will be according to the following outline:

1. General summary.
2. Summary of determinations made during definite periods of time.
3. Summary of determinations made under different wind conditions.
4. Details of daily tests, segregated according to wind conditions.
5. Details of determinations made under most unfavorable wind and smoke conditions.

DETAILS OF DETERMINATIONS AT STATION 1.[a]

Determinations made as follows:

Month.	Year.	Investigator.
September	1913	A. E. Wells and G. N. Libby.
October	1913	A. E. Wells and J. D. Enas.
November	1913	A. E. Wells and J. D. Enas.
March	1914	J. D. Enas.
April	1914	J. D. Enas and R. W. Noreen.
May	1914	J. D. Enas and R. W. Noreen.

[a] See Plate VI.

GENERAL SUMMARY.

Total number of samples, 1,989.

Average sulphur dioxide content of samples, 0.22 part SO_2 per million parts of air.

Maximum sulphur dioxide content of samples, 2.40 parts SO_2 per million parts of air.

Range of results—

Range of results of determinations at station 1.

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	1,464	73.60
.2 to .4	308	15.50
.4 to .6	141	7.10
.6 to .8	48	2.40
.8 to 1.0	18	.90
1.0 to 1.5	6	.30
1.5 to 2.0	3	.15
2.0 to 2.5	1	.05
	1,989	.....

Thus, of the 1,989 samples taken at station 1, the point where was found the maximum contamination of the air of Benicia, due to the Selby smelter, 1,464, or 73.6 per cent, contained less than 0.2 part SO_2 per million parts of air; 1,772, or 89.1 per cent, contained less than 0.4 part SO_2 per million parts of air; and 1,979, or 99.5 per cent contained less than 1.0 part SO_2 per million.

SUMMARY OF DETERMINATIONS MADE DURING DEFINITE PERIODS OF TIME.

A summary of determinations made during definite periods of time follows:

Summary of SO_2 determinations during various periods of time.

Month or time.	Number.	Proportion of total.	Parts SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
September [a]	34	1.7	0.43	1.15
October	416	20.9	< .20	2.40
November	511	25.7	< .20	.90
March	180	9.1	< .20	1.00
April	553	27.8	.25	.90
May	295	14.8	.30	1.00
	1,989	100.0	.....	.....
4 a. m. to 8 a. m.	101	5.1	.20	.60
8 a. m. to 12 m.	915	46.1	.20	1.00
12 m. to 6 p. m.	973	48.8	.25	2.40
	1,989	100.0	.....	.....

[a] The tests in September were made only at times when the wind was blowing the Selby smoke directly to station 1. This explains why the average for September is higher than for the other months, which include the determinations made under all wind conditions.

SUMMARY OF DETERMINATIONS MADE UNDER VARIOUS WIND CONDITIONS.

Following is a summary of determinations made during various wind conditions:

Summary of SO_2 determinations during various wind conditions.

Condition of wind.	Number of determinations.	Proportion of total.	Parts SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
Slight west or almost calm	306	15.4	0.35	2.40
Moderate or brisk west wind	585	29.5	.25	1.00
South or southwest	304	15.3	< .20	.40
East or southeast	283	14.2	< .20	.80
North or northeast	162	8.1	< .20	.40
Northwest wind	349	17.5	< .20	.60
	1,989	100.0	.....	.....

DETAILS OF DAILY TESTS, SEGREGATED ACCORDING TO WIND CONDITIONS.

The following tables give the average and the maximum sulphur dioxide content of the samples taken under the different wind conditions on different days. In the tables giving the data for slight west wind and for moderate or brisk west wind conditions, the rate of sulphur elimination from the Selby plant is also given.

Details of 306 determinations made at station 1, when there was a slight west wind.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.	Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.				Average.	Maximum.	
1913.				*Tons.*	1914.				*Tons.*
Sept. 17	18	0.60	1.15	30	Apr. 6	5	0.30	0.40	28
Oct. 10	5	1.00	2.40	21	7	16	.50	.80	27
16	19	< .20	.20	2	8	23	.20	.40	33
17	24	< .20	.20	18	11	13	< .20	.40	28
20	7	.75	1.60	8	13	21	.20	.40	27
27	28	.50	1.90	40	14	20	.30	.80	20
28	27	.40	1.50	40	17	4	.70	.80	21
Nov. 10	14	.50	.90	33	21	1	.20	.20	23
					27	7	.60	.80	25
1914.					May 1	4	.40	.60	27
Mar. 20	5	< .20	.40	24	10	16	.40	.60	38
25	18	.30	1.00	31					
27	6	.25	.40	28		306	.35	.....	.....
2	5	.50	.60	23					

Details of 585 determinations made at station 1, when there was a moderate or brisk west wind.

Date.	Number of tests.	Parts of SO_2 per million parts of air		Rate of sulphur elimination from smelter per 24 hours.	Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.				Average.	Maximum.	
1913.				*Tons.*	1914.				*Tons.*
Sept. 24	16	0.25	0.4	22	Apr. 3	8	0.25	0.4	27
Oct. 12	2	< .20	.2	29	5	16	< .20	.2	23
13	5	.30	.4	14	6	12	< .20	.4	28
14	7	< .20	.2	16	10	13	.25	.6	27
15	4	.40	.8	14	15	15	.25	.8	16
21	4	.20	.3	16	16	10	.40	.8	16
22	24	< .20	.2	11	19	2	.40	.4	26
23	19	< .20	.2	12	20	11	.20	.4	27
29	25	.20	.8	38	22	13	.50	1.0	21
30	5	.40	.8	16	23	12	.35	.6	33
31	23	< .20	.2	11	24	18	.40	.6	28
Nov. 2	10	.30	.4	10	25	18	.35	.6	29
3	19	< .20	.6	19	26	19	.45	.6	27
6	10	< .20	.3	11	27	11	.50	.8	25
15	10	.30	.9	16	28	10	.50	.8	21
16	13	.20	.6	14	May 1	5	.30	.6	27
21	8	.30	.4	35	2	10	.35	.4	25
22	16	.20	.5	36	3	18	.65	1.0	26
28	9	< .20	.2	0	5	12	.50	.8	29
29	6	< .20	.2	40	6	5	.70	.8	41
					7	22	.50	.7	40
1914.					8	17	.30	.6	36
Mar. 21	9	.30	.5	31	9	13	.35	.8	25
22	11	< .20	.4	31	11	6	.40	.6	45
26	17	.20	.4	22					
27	17	.25	.4	28		585	.25	.....	.....

Details of 304 determinations made at station 1, when the wind was from the south or southwest.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Date.	Number of tests.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.			Average.	Maximum.
1913.				1914.			
Oct. 13	13	<0.20	<0.20	Apr. 10	7	<0.20	0.20
Oct. 14	9	< .20	< .20	Apr. 17	1	.40	.40
Oct. 25	14	< .20	< .20	Apr. 20	13	< .20	.20
Nov. 1	10	< .20	< .20	Apr. 21	3	< .20	.20
Nov. 10	8	< .20	< .20	Apr. 22	9	.20	.40
				Apr. 23	8	.20	.40
1914.				May 4	20	< .20	.40
Mar. 23	8	.20	.60	May 6	9	.30	.40
Mar. 24	22	< .20	.60	May 8	3	< .20	.20
Mar. 25	6	< .20	.60	May 10	6	< .20	.20
Mar. 26	3	< .20	.20	May 11	8	< .20	.40
Mar. 28	15	.20	.40	May 13	22	< .20	.40
Mar. 31	16	< .20	.20	May 14	20	< .20	.20
Apr. 3	12	< .20	.20				
Apr. 4	15	< .20	< .20		304	< .20	.....
Apr. 9	24	< .20	.20				

Details of 283 determinations made at station 1, when the wind was from the east or southeast.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Date.	Number of tests.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.			Average.	Maximum.
1913.				1914.			
Oct. 26	16	<0.20	<0.20	Mar. 23	4	<0.20	<0.20
Nov. 4	21	< .20	< .20	Mar. 30	9	< .20	.40
Nov. 5	25	< .20	< .20	Apr. 2	16	< .20	.80
Nov. 6	10	< .20	< .20	Apr. 17	9	.20	.25
Nov. 7	29	< .20	.30	Apr. 18	12	< .20	< .25
Nov. 11	13	< .20	< .20	Apr. 21	15	< .20	< .25
Nov. 13	7	< .20	< .20	May 9	9	< .20	.20
Nov. 17	12	< .20	< .20		283	< .20	.....
Nov. 18	5	< .20	< .20				
Nov. 24	19	< .20	< .20				
Nov. 25	15	< .20	< .20				
Nov. 26	17	< .20	< .20				
Nov. 28	10	< .20	< .20				

Details of 162 determinations made at station 1, when there was a north or northeast wind.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Date.	Number of tests.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.			Average.	Maximum.
1913.				1914.			
Oct. 11	21	<0.20	0.40	Mar. 17	11	<0.20	<0.20
Oct. 18	19	< .20	< .20	Mar. 23	3	< .20	< .20
Oct. 20	17	< .20	< .20	Apr. 1	16	< .20	.20
Nov. 8	18	< .20	< .20	Apr. 11	3	< .20	< .20
Nov. 13	7	< .20	< .20	Apr. 18	4	< .20	< .20
Nov. 14	18	< .20	< .20	Apr. 21	1	< .20	< .20
Dec. 1 and 3	24	< .20	< .20		162	< .20	.....

Details of 349 determinations made at station 1, when the wind was north of west.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Date.	Number of tests.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.			Average.	Maximum.
1913.				1914.			
Oct. 12	12	<0.20	<0.20	Apr. 19	16	<0.20	0.20
Oct. 14	15	< .20	< .20	Apr. 21	1	< .20	< .20
Oct. 15	20	< .20	< .20	Apr. 23	2	< .20	.40
Oct. 21	20	< .20	< .20	Apr. 25	1	< .20	< .20
Oct. 24	16	< .20	< .20	Apr. 27	5	.25	.40
Oct. 30	19	< .20	< .20	Apr. 28	11	.30	.40
Nov. 2	8	< .20	.20	Apr. 29	18	< .20	< .20
Nov. 3	4	< .20	.20	Apr. 30	13	< .20	< .20
Nov. 6	14	< .20	.30	May 1	14	.25	.40
Nov. 15	18	< .20	.30	May 2	10	< .20	.40
Nov. 19	24	< .20	< .20	May 5	6	.50	.60
Nov. 20	9	< .20	< .20	May 6	4	.50	.60
Nov. 21	15	< .20	< .20	May 8	3	.50	.60
Nov. 29	5	< .20	< .20	May 11	11	< .20	.40
1914.				May 12	22	.20	.40
Apr. 16	9	< .20	.20		349	< .20	.....
Apr. 17	6	< .20	.20				

DETAILS OF DETERMINATIONS MADE UNDER MOST UNFAVORABLE WIND AND SMOKE CONDITIONS.

In the following pages are given the individual tests made on certain days when the smoke conditions apparently were the worst for Benicia. There was only a slight drift of air from the west, and the smoke could be seen floating along the straits directly to Benicia. It is difficult to believe that, with the same amount of sulphur dioxide coming from the smelter stack, the concentrations of sulphur dioxide in the air at Benicia could be greater than those found as shown below.

SEPTEMBER 17, 1913.

Smelter data.

Number sintering machines in operation, 3.
Rate of sulphur elimination, 30 tons per 24 hours.
Wind record at smelter, calm or slight southwest.

Station 1 data.[a]

Tabulated data for station 1 follow.

Results of SO_2 determinations at station 1, Sept. 17, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.
p. m.		
1.45	0.8	Light west wind; smoke coming direct from smelter to station; very hazy and smoky around station. Believe the wind and smoke condition the worst possible for the sulphur output.
1.55	.3	
2.05	.8	
2.15	.5	
2.30	.5	
3.00	.5	
3.10	.5	
3.25	.4	
3.40	.6	
3.50	.4	
4.30	.9	At 5.30 a little breeze came up from the west, clearing the air somewhat.
5.15	1.1	
5.25	1.0	
5.35	.9	
5.45	.6	
5.55	.5	
6.10	.3	
6.30	.3	

OCTOBER 10, 1913.

Smelter data.

Number sintering machines in operation, 2.
Rate of sulphur elimination, 21 tons per 24 hours.
Wind record at smelter, calm.

[a] Determinations made by A. E. Wells and G. N. Libby. During the time these tests were being made the air was very hazy and smoky. It was not possible to see across the straits to Port Costa. Mr. J. C. Fisher claimed that it was a very bad "smelter day" and that between 2 and 2.30 p. m. he could smell the smoke. Could not detect the smell myself. The haze and smoke was general and was not confined to the Selby "smoke zone."—A. E. Wells.

Station 1 data.[a]

Tabulated data for station 1 follow.

Results of SO_2 determinations at station 1, Oct. 10, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.
p. m.		
2.45.....	2.4	Calm. Dense haze and smoke drifting in from the west direct to station. No odor of SO_2.
3.00.....	1.5	Clearing a little at the station, but very hazy all along the straits.
3.15.....	.3	Clearing all around; still very calm. No perceptible change in the velocity or direction of the wind.
4.00.....	.4	Clearer.
4.15.....	.4	Do.

October 20, 1913.

Smelter data.

Number of sintering machines in operation, 1.
Rate of sulphur elimination, 8 tons per day.
Wind record at smelter, calm.

Station 1 data.[b]

Following are tabulated data for station 1.

Results of SO_2 determinations at station 1, Oct. 20, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.
p. m.		
3.10.....	0.8	Calm. Very slight drift from the west. Very smoky around station.
3.25.....	.6	
3.40.....	1.0	
4.00.....	1.6	
4.15.....	.9	
4.20.....	.2	Calm. Clearing around station.
4.30.....	.1	Calm, clear.

SPECIAL NOTE BY A. E. WELLS.—After 2.30 p. m. there was a very slight drift of air from the west. No perceptible change in direction and velocity at station 1 between 3 and 4.30 p. m., yet a decided change in SO_2 concentrations was found during that time.

October 27, 1913.

Smelter data.

Number of sintering machines in operation, 2.
Ropp roaster in operation.
Rate of sulphur elimination, 40 tons per 24 hours.
Wind record at smelter, calm.

[a] Determinations made by A. E. Wells.
[b] Determinations made by J. D. Enas.

Station 1 data.[a]

Following are tabulated data for station 1.

Results of SO_2 determinations at station 1, Oct. 27, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.
a. m.		
7.55	0.2	Hazy light northwest wind.
8.50	.2	Do.
8.35	.2	Do.
8.50	.2	Do.
9.05	.4	Light west wind.
9.15	.2	Do.
9.45	.4	Do.
10.00	.2	Do.
10.25	.4	Do.
10.40	.3	Do.
10.55	.4	Do.
11.20	.3	Do.
11.35	.4	Do.
11.55	.2	Do.
p. m.		
12.15	.2	Do.
1.10	1.9	Smoke in the vicinity.
1.20	.4	Do.
1.40	1.9	Do.
2.15	1.2	Do.
2.30	.6	Do.
2.45	.2	Clearing.
3.00	.6	Smoky, strong oil smell.
3.10	.7	Do.
3.20	1.2	Do.
3.55	.6	Do.
4.15	.3	Do.
4.30	.2	Do.
4.45	.2	Do.

After 5 p. m. a moderate breeze came up, clearing the air.

SPECIAL NOTE BY A. E. WELLS.—During the morning the smoke lay very close to the Contra Costa shore, about noon began to drift out more nearly to the north side of the straits, and was noticed over station 1. At 1.30 p. m. the general wind was about the same, yet the smoke had cleared at station 1. The smoke again drifted in at 1.40 p. m. At 2 p. m. it was clear around station 1.

OCTOBER 28, 1913.

Smelter data.

Number of sintering machines in operation, 2.

Ropp roaster in operation.

Rate of sulphur elimination, 40 tons per 24 hours.

Wind record at the smelter, west and calm; maximum velocity, 6 miles per hour.

[a] Determinations made by J. D. Enas.

Station 1 data.[a]

Following are tabulated data for station 1:

Results of SO_2 determinations at station 1, Oct. 28, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.	
		Wind.	Smoke.
a. m.			
4.00	0.4	Calm	Slightly hazy.
4.15	.4		
4.30	.4		
4.45	.4	Slight west	
5.00	.4	do	
5.15	.4	do	
5.30	.2	do	
8.40	.2	do	Smoky along straits.
9.10	.2	do	Do.
9.25	.2	do	Do.
9.55	.2		
10.30	.1		
10.55	.2		
11.15	.6		
11.30	.6		Smoky along straits and in vicinity.
11.40	.5		Smoke spreading over vicinity.
11.50	.5		Do.
p. m.			
12.10	.3		
12.40	1.5		
1.00	.8		
1.10	.9		
1.30	.4		Smoke clearing up.
1.45	.2		
2.00	.2		
2.25	.2		Smoke spreading over station.
2.35	.2		
2.45	.2		Wind increasing in strength, clearing the air.

NOTE BY A. E. WELLS.—About noon the smoke was visible drifting over Benicia. Appeared densest around station 1. Cleared up by 1.15 p. m.

MAY 10, 1914.

Smelter data.

Number of sintering machines, 3.
Ropp roaster in operation.
Rate of sulphur elimination, 38 tons per 24 hours.
Wind, west; velocity, 3 miles per hour.

[a] Determinations made by J. D. Enas.

Station 1 data.

Tabulated data for station 1 follow.

Results of SO_2 determinations at station 1, May 10, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.
a. m.		
6.50	0.6	Direct west wind; clear.
7.25	.4	Light west wind; clear.
7.40	.4	Do.
7.50	.4	Do.
8.25	.4	Do.
8.40	.4	Do.
8.50	.4	Do.
9.25	.6	Do.
9.40	.4	Do.
9.50	.4	Do.
10.20	.4	Do.
10.35	.4	Do.
10.50	.4	Do.
11.20	.2	Light south of west wind; clear.
11.35	.2	Do.
11.50	.4	Light western breeze; clear.
p. m.		
1.20	<.2	Light south breeze; clear.
1.45	<.2	Do.
2.20	<.2	Do.
2.45	<.2	Light south of west breeze; clear.
3.25	.4	Light west wind; clear.
3.50	.4	Do.

GENERAL COMMENTS.

An interesting and significant illustration of the conditions in the Selby "smoke zone" is shown from the results obtained during light west wind conditions. Even under fairly constant general wind conditions the average and maximum contamination of the air at a point situated at station 1, 4½ miles from the smelter, is not always proportional to the sulphur dioxide output from the smelter. As an example of this feature, compare the determinations made on September 17, October 10, 17, 20, and 27, when the general wind conditions were almost identical.

Examples of disagreement between variations in air contamination and variations in sulphur output from smelter.

Date.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
	Average.	Maximum.	
1913.			*Tons.*
Oct. 16	<0.20	0.20	2
Oct. 20	.75	1.60	8
Oct. 17	<.20	.20	18
Oct. 10	1.00	2.40	21
Apr. 21	.20	.20	23
Sept. 17	.60	1.15	30
Oct. 27	.50	1.90	40

Thus, on the 10th of October, when the smelter was turning out sulphur dioxide at the rate of 42 tons per day, the concentration reached 2.4 parts SO_2 per million parts of air at station 1, as against

a maximum of 0.4 part SO_2 per million parts of air found on April 21, when the wind conditions were about the same and the smelter output was a little greater. The wide difference in sulphur dioxide concentration under nearly the same general wind conditions and the same output of sulphur dioxide from the smelter shows the great influence of slight and local wind changes or other atmospheric conditions.

At no time during the investigations was there a continuous drift of air carrying more than 1 part SO_2 per million parts of air past the station for more than a few minutes at a time. Only when there were puffs of smoke passing was the sulphur dioxide content of the air raised appreciably. Whenever the wind was above a slight breeze or drift these puffs were dispersed and dissipated, so that no high concentrations were present.

From these "instantaneous" samples it is not possible to state definitely how long any certain concentration was present at any time. It will be noted from the above data that the highest concentrations were only in isolated samples. No case of continuous high concentrations (over 1 part SO_2 per million parts of air) lasting more than the time between the taking of two consecutive samples, about 20 minutes, was recorded. The following figures have been prepared to show the approximate length of time that concentrations above 0.5 part SO_2 per million parts of air existed during any day:

Approximate length of time certain concentrations of SO_2 were present in the air at station 1, with a west wind.

Number of parts of SO_2 per million parts of air.	Date.	Length of time.	Number of parts of SO_2 per million parts of air.	Date.	Length of time.
	1913.	*Minutes.*		1914.	*Minutes.*
2 to 2.5[a]	Oct. 10	[b] 5	More than 0.5	Mar. 25	60
				Apr. 2	120
More than 1	Sept. 17	60		Apr. 7	120
	Oct. 10	30		Apr. 10	20
	Oct. 20	15		Apr. 14	30
	Oct. 27	90		Apr. 15	30
	Oct. 28	15		Apr. 16	15
	May 10	15		Apr. 22	30
				Apr. 23	30
Total		[c] 225		Apr. 24	60
				Apr. 25	10
More than 0.5	Sept. 17	300		Apr. 26	60
	Oct. 10	30		Apr. 27	360
	Oct. 15	10		Apr. 28	180
	Oct. 20	75		May 1	10
	Oct. 27	180		May 3	360
	Oct. 28	90		May 5	270
	Oct. 29	10		May 6	150
	Oct. 30	20		May 7	240
	Nov. 10	45		May 8	60
	Nov. 15	15		May 10	30
			Total		[d] 3,020

[a] More than 2 and less than 2.5.
[b] Approximate.
[c] 225 minutes out of about 43,200 minutes of sampling time, or 0.5 per cent.
[d] 3,020 minutes out of 43,200 minutes of sampling time, or 7 per cent.

DETAILS OF DETERMINATIONS MADE ON THE VALLEJO-BENICIA ROAD, BETWEEN SHIPYARD AND BENICIA CITY LIMITS, NEAR CARTY'S PLACE.

GENERAL SUMMARY.

Total number of samples, 339.

Average sulphur dioxide content of samples, 0.2 part of SO_2 per million parts of air.

Maximum sulphur dioxide content, 1.25 parts of SO_2 per million parts of air.

Range of results of determinations made on Vallejo-Benicia road.

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	261	76.9
.2 to .4	43	12.7
.4 to .6	24	7.1
.6 to .8	6	1.8
.8 to 1.0	4	1.2
1.0 to 1.5	1	.3
Total	339	100.0

DETAILED RESULTS.

Following are tabulations showing the results of SO_2 determinations:

Summary of determinations made at different time periods.

Month or time.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.		Investigator.
			Average.	Maximum.	
1913.		*Per cent.*			
September	7	2.1	0.35	0.6	A. E. Wells.
October	75	22.1	.20	.8	G. N. Libby.
November	38	11.2	.20	.4	Do.
1914.					
April	66	19.5	.25	.6	H. L. Long.
May	153	45.1	.25	1.25	Do.
Total	339	100.0	.....	.....	
4 a. m. to 8 a. m.	4	1.2	.50	.65	
8 a. m. to 12 m.	199	58.8	.20	.80	
12 m. to 6 p. m.	136	40.0	.20	1.25	
	339	100.0	.....	.....	

Summary of determinations made under various wind conditions.

Condition of wind.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
Slight west wind	58	17.1	0.27	0.75
Moderate or high west wind	106	31.3	.30	1.25
South or southwest wind	75	22.1	< .20	.80
East or southeast wind	29	8.6	< .20	.30
North or northeast wind	.....	.....	.....	.....
Northwest wind	71	20.9	< .20	.40
	339	100.0	.....	.....

Details of determinations made on the Vallejo-Benicia road, between shipyard and city limits.

SLIGHT WEST WIND BLOWING.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.	
1913.				*Tons.*
Sept. 18	4	0.55	0.65	32
Oct. 4	4	.25	.40	12
Oct. 25	17	.25	.80	9
Nov. 8	8	.10	.40	11
1914.				
Apr. 3	6	< .20	< .20	27
Apr. 8	8	.20	.60	32
May 11	2	< .20	< .20	45
May 10	9	.40	.75	38
	58	.27	.....	.....

MODERATE OR BRISK WEST WIND BLOWING.

1913.				
Oct. 29	17	0.20	0.40	38
1914.				
Apr. 16	4	.50	.60	16
Apr. 25	11	.35	.60	29
May 2	14	.40	.80	25
May 3	20	.20	.50	26
May 4	20	.20	.60	28
May 9	13	.30	.75	25
May 12	7	.80	1.25	36
	106	.30	.....	.....

SOUTH OR SOUTH OF WEST WIND BLOWING.

1913.				
Oct. 6	15	<0.20	<0.20	.....
1914.				
Apr. 25	8	< .20	< .20	.....
Apr. 28	10	.40	.80	.....
May 8	6	.25	.25	.....
May 9	5	< .20	< .25	.....
May 12	13	< .20	< .25	.....
May 13	18	< .25	.25	.....
	75	< .20	.....	.....

Details of determinations made on the Vallejo-Benicia road, between shipyard and city limits—Continued.

EAST OR SOUTHEAST WIND BLOWING.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.	
1913.				*Tons.*
Nov. 14	12	<0.20	<0.20	.....
1914.				
Apr. 17	5	< .20	.20	.....
Apr. 21	8	< .25	.25	.....
May 10	4	< .20	< .20	.....
	20	< .20	.....	.....

NORTHWEST WIND BLOWING.

1913.				
Sept. 18	3	<0.20	0.25	.....
Oct. 4	8	< .20	< .20	.....
Oct. 10	9	< .20	< .20	.....
Oct. 24	16	< .20	.20	.....
Nov. 22	7	< .20	.20	.....
1914.				
Apr. 16	4	.25	.40	.....
Apr. 28	2	< .25	.25	.....
May 2	8	< .20	.25	.....
May 11	10	< .20	.25	.....
May 12	4	< .20	.25	.....
	71	< .20	.....	.....

NORTH OR NORTHEAST WIND BLOWING.

No determinations.

DETAILS OF DETERMINATIONS MADE UNDER MOST UNFAVORABLE WIND AND SMOKE CONDITIONS.

The data of September 18 and May 13, when the maximum concentrations were found, are given below:

SEPTEMBER 18, 1913.

Smelter data.

Number of sintering machines in operation, 3.
Rate of sulphur elimination, 32 tons per 24 hours.
Wind record at smelter, west and southwest, one-half mile per hour.

Sampling station data.

Tabulated data for the sampling station follow.

Results of determinations at sampling station on Vallejo-Benicia Road, September 18, 1913.[a]

Time.	Parts of SO_2 per million parts of air.[a]	Notes.
a. m.		
7.00	0.6	Very light west wind; hazy.
7.50	.5	Do.
8.15	.6	Do.
8.30	.5	Very light west and northwest wind; hazy.
8.40	.25	Very light northwest wind.
8.55	< .20	Do.
9.10	< .20	Do.

[a] Determinations made by A. E. Wells.

MAY 12, 1914.

Smelter data.

Number of sintering machines in operation, 3.
Ropp roaster in operation.
Rate of sulphur elimination, 38 tons per 24 hours.
Wind record at smelter, southwest, 4 to 5 miles per hour.

Results of determinations[a] *at sampling station on Vallejo-Benicia Road, May 12, 1914.*

Time.[b]	Parts of SO_2 per million parts of air.	Notes.
a. m.		
11.35	0.6	Moderate southwest wind.
11.45	.6	Do.
11.55	.8	Do.
p. m.		
12.10	1.0	Smoke coming past Dillon Point to station.
12.20	1.25	Do.
12.30	.8	Clearing at station.
12.45	.2	Clear at station.
1.00	.2	Southwest wind.

[a] Determinations by H. L. Long.
[b] Between 1.00 p. m. and 2.00 p. m. no samples were taken. After 2.00 p. m. the wind was from the southwest, and no sample carried more than 0.2 part of SO_2 per million parts of air.

DETAILS OF DETERMINATIONS MADE NORTH OF VALLEJO-BENICIA ROAD, BETWEEN BURKE'S SALOON AND THE SHIPYARD.

GENERAL SUMMARY.

Total number of samples, 89.

Average sulphur-dioxide content of samples, 0.23 part of SO_2 per million parts of air.

Maximum sulphur-dioxide content of samples, 1.10 parts of SO_2 per million parts of air.

Range of results—

Range of results of SO_2 determinations made north of Vallejo-Benicia Road.

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	63	70.7
.2 to .4	4	4.5
.4 to .6	12	13.5
.6 to .8	4	4.5
.8 to 1.0	2	2.3
1.0 to 1.5	4	4.5
	89	100.0

DETAILED RESULTS.

Following are tabulations giving detailed results of determinations:

Summary of determinations made during definite periods of time.

Month or time.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
1913.				
September				
October	76	85.5	0.25	1.1
November	13	14.5	< .20	.2
1914.				
March				
April				
May				
Total	89	100.0		
4.00 a. m. to 8 a. m.	5	5.6	.30	.4
8.00 a. m. to 12 m.	43	48.3	.24	1.0
12.00 m. to 6 p. m.	41	46.1	.20	1.1
	89	100.0		

Details of determinations made under different wind conditions.

LIGHT WEST WIND BLOWING.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.	
				Tons.
Oct. 14	22	0.40	1.00	16
Oct. 16	21	< .20	.40	2
Oct. 27	20	.40	1.10	40
Nov. 4	13	< .20	.20	17
	76			

STRONG WEST WIND BLOWING.

No determinations made.

SOUTH, SOUTHWEST, NORTH, NORTHWEST, OR NORTHEAST WIND.

No determinations made.

EAST OR SOUTHEAST WIND BLOWING.

Oct. 31	13	<0.20	0.20	

DETAILS OF DETERMINATIONS MADE UNDER MOST UNFAVORABLE WIND AND SMOKE CONDITIONS.

The data obtained on October 27, when the maximum amount of sulphur dioxide in this series was found, are given below.

OCTOBER 27, 1913.

Place of sampling—near deserted farmhouse, in Dana place, about one-half mile north of Vallejo-Benicia Road.

Number of sintering machines in operation, 3.
Ropp roaster in operation.
Rate of sulphur elimination, 40 tons per day.
Wind record at smelter, calm.

Results of determinations made near deserted farmhouse in Dana place, about one-half mile north of Vallejo-Benicia Road.[a]

Time.	Parts of SO_2 per million parts of air.	Notes.
11.00 a. m. to 2.45 p. m...	<0.20	Light west wind.
3.00 p. m...	1.10	Smoke puffs drifting past.
3.20 p. m...	1.10	Do.
3.30 p. m...	.40	Do.
3.45 p. m...	< .20	Do.
4.05 p. m...	.80	Slight odor of SO_2.
4.15 p. m...	.70	Smoky in vicinity.
4.30 p. m...	1.00	Do.
4.35 p. m...	.70	Do.
4.50 p. m...	< .20	Clear.

[a] Determinations made by G. N. Libby.

DETAILS OF DETERMINATIONS MADE IN THE RESIDENTIAL PORTION OF BENICIA EAST OF BURKE'S SALOON, INCLUDING THE DISTRICT ON THE HILLS NORTH OF K STREET AND EAST TO ARSENAL.[a]

GENERAL SUMMARY.

Total number of samples, 242.

Average sulphur dioxide content of samples, 0.2 part of SO_2 per million parts of air.

Maximum sulphur dioxide content of samples, 1.7 parts of SO_2 per million parts of air.

Range of results—

Range of results of sampling in the residential portion of Benicia, east of Burke's saloon.

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	182	75.2
.2 to .4	23	9.5
.4 to .6	13	5.4
.6 to .8	16	6.6
.8 to 1.0	1	.4
1.0 to 1.5	5	2.1
1.5 to 2.0	2	.8
	242	100.0

[a] September, October, and November determinations by G. N. Libby; May and April determinations by H. L. Long.

Summary of tests made during definite periods of time.

Month or time.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
September	44	18.2	0.60	1.70
October	131	54.1	.20	.60
November	45	18.6	< .20	.20
March	.....	.....	.....	.....
April	13	5.4	< .20	.20
May	9	3.7	.20	.25
	242	100.0	.....	.....
4 a. m. to 8 a. m.	20	8.3	.25	.60
8 a. m. to 12 m.	100	41.3	< .20	1.10
12 m. to 6 p. m.	122	50.4	.25	1.70
	242	100.0	.....	.....

Summary of determinations made under various wind conditions.

Direction of wind.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
Slight west wind	94	38.8	0.20	1.7
Moderate or strong west wind	75	31.0	.35	1.1
South or southwest wind	18	7.4	< .20	.2
East or southeast wind	44	18.2	< .20	.2
North or northeast wind	11	4.6	< .20	.2
Northwest wind	.....	.....	.....	.....
	242	100.0	.....	.....

DETAILED RESULTS.

Detailed results follow.

Details of determinations made in the residential portions of Benicia, east from Burke's saloon, including the district on the hills north of K Street and east of the arsenal.

SLIGHT WEST WIND BLOWING.

Date.	Place of taking sample.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
			Average.	Maximum.	
1913.					*Tons.*
Sept. 25	Near Kuhlman's house, at end of G Street.	5	1.30	1.7	26
Oct. 7	Corner of K and Main Streets	2	.45	.5	12
Oct. 17	K Street, near Prince's residence	23	< .20	.4	18
Oct. 22	Hill near E. Selby's	18	< .20	.6	12
Oct. 23	U. S. Arsenal	17	< .20	.2	10
Oct. 28	Catholic cemetery	22	.20	.35	40
1914.					
Apr. 28	U. S. Arsenal	7	< .20	.2	21
		94	.20	.....	.....

Details of determinations made in the residential portions of Benecia, east from Burke's saloon, including the district on the hills north of K Street and east of the arsenal—Con.

MODERATE OR BRISK WEST WIND BLOWING.

Date.	Place of taking sample.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
			Average.	Maximum.	
1913.					*Tons.*
Sept. 25	Near Kuhlman's house, end of G Street.	16	0.70	1.0	26
Sept. 27	do	23	.30	1.1	18
Oct. 15	Near high school	9	.25	.4	14
Oct. 21	Near cemetery north of town	22	.20	.6	11
1914.					
May 12	On hill near Eben Selby's residence.	5	< .20	.25	28
		75			

SOUTH AND SOUTHWEST WIND BLOWING.[a]

Date.	Place.	Number of tests.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
1913.				
Oct. 7	K and Main Streets	13	<0.20	<0.20
Oct. 15	Near high school	5	< .20	< .20
		18		

EAST OR SOUTHEAST WIND BLOWING.

1913.				
Nov. 17	United States arsenal	5	<0.20	0.20
Nov. 25	do	13	< .20	.20
Nov. 26	do	16	< .20	.20
1914.				
Apr. 17	do	6	< .20	< .20
May 5	do	4	< .20	< .20
		44	< .20	

NORTH OR NORTHEAST WIND BLOWING.

1913.				
Nov. 8	K Street near Burke's saloon	11	<0.20	0.20

[a] When the wind was from the east and southeast the Mountain Copper smoke was sometimes headed toward Benicia, especially Army Point. However, as shown by the analyses of Nov. 17, 25, and 26, and Apr. 17 and May 5, no samples taken during those conditions contained more than 0.20 part SO_2 per million parts of air.

DETAILS OF DETERMINATIONS MADE UNDER MOST UNFAVORABLE WIND AND SMOKE CONDITIONS.

Details of the determinations made on September 25, when the highest concentrations of any samples included in this series were obtained, are given below:

SEPTEMBER 25, 1913.

Place of sampling, near residence of Mr. Kuhlman and Mr. Crooks, at end of G Street.

Number of sintering machines in operation, 3.

Rate of sulphur elimination, 28 tons per day.

Wind record at Selby—11 a. m., west, 2-mile velocity; 3 p. m., west, 10-mile velocity.

Results of samples taken at end of G Street.[a]

Time.	Parts of SO_2 per million parts of air.	Notes.	Time.	Parts of SO_2 per million parts of air.	Notes.
p. m.			*p. m.*		
12.30	1.0	Almost calm, slight drift from west; smoky.	2.55	0.6	Moderate west breeze; clear.
			3.10	.7	Do.
12.50	1.7	do	3.20	.6	Do.
1.15	1.3	do	3.40	1.0	Do.
1.30	1.7	do	4.05	.8	Do.
1.50	.7	Slight breeze from west; clearer.	4.15	.8	Do.
			4.25	.8	Do.
2.00	.6	Breeze blowing up briskly from west; clear.	4.35	.5	Do.
			4.50	.5	Do.
2.15	.6	Moderate west breeze; clear	5.00	.4	Do.
2.25	.6	do	5.20	.4	Do.
2.45	.4	do	5.45	.4	Do.

[a] Determinations made by A. E. Wells and G. N. Libby.

DETAILS OF DETERMINATIONS MADE IN THE BUSINESS SECTION OF BENICIA, SOUTH OF J STREET.

GENERAL SUMMARY.

Total number of samples, 182.

Average sulphur dioxide content of samples, less than 0.20 part of SO_2 per million parts of air.

Maximum sulphur dioxide content of samples <1 part of SO_2 per million parts of air.

Range of results -

Range of results of sampling in the business section of Benicia, south of J Street.

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	159	87.4
.2 to .4	8	4.4
.4 to .6	7	3.8
.6 to .8	6	3.3
.8 to 1.0	2	1.1
	182	100.0

Summary of determinations made within certain time limits.

Month or time.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
September				
October	34	18.7	<0.20	0.6
November	97	53.3	< .20	.7
March				
April	22	12.1	< .20	.4
May	29	15.9	.30	1.0
	182	100.0		
4 a. m. to 8 a. m	6	3.3	< .20	.2
8 a. m to 12 m	43	23.6	< .20	1.0
12 m. to 6 p. m	133	73.1	< .20	.7
	182	100.0		

DETAILS OF DAILY TESTS SEGREGATED ACCORDING TO WIND CONDITIONS.

The details of daily tests segregated according to wind conditions are tabulated below.

Details of daily tests segregated according to wind conditions.

SLIGHT WEST WIND BLOWING.

Date.	Place of sampling.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
			Average.	Maximum.	
1913.					*Tons.*
Oct. 20	City wharf	13	<0.20	0.6	8
Nov. 9	Anderson Hotel	2	.60	.6	11
Nov. 21	do	18	< .20	.4	35
Nov. 22	K. & S. Tannery	10	< .20	.7	36
		43	< .20		

BRISK OR MODERATE WEST WIND BLOWING.

1913.					
Oct. 8	Anderson Hotel	4	<0.20	0.4	11
Oct. 9	do	17	< .20	< .2	11
Nov. 19	One block south of Anderson Hotel.	18	< .20	.2	16
1914.					
Apr. 16	Anderson Hotel	6	< .20	.2	18
Apr. 25	do	6	.20	.4	29
Apr. 28	do	4	< .20	.2	21
May 2	do	10	< .20	.4	24
May 11	do	5	.80	1.0	45
		70	< .20		

SOUTH OR SOUTHWEST WIND BLOWING.

1913.					
Nov. 9	Anderson Hotel	8	<0.20	0.2	

Details of daily tests segregated according to wind conditions—Continued.

EAST OR SOUTHEAST WIND BLOWING.

Date.	Place of sampling.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
			Average.	Maximum.	
1913.					*Tons.*
Nov. 7	City wharf	23	0.20	0.8	.....
1914.					
Apr. 17	Anderson Hotel	6	< .20	.2	.....
		29	.....	.....	.....

NORTHWEST WIND BLOWING.

1913.					
Nov. 20	City wharf	18	<0.20	0.2	.....
1914.					
May 11	Anderson Hotel	4	.25	.5	.....
May 12	do	10	< .25	.5	.....
		32	.....	.....	.....

DETAILS OF DETERMINATIONS AT STATION 2.

GENERAL SUMMARY.

Total number of samples, 1,773.

Average sulphur dioxide content of samples, 0.25 part SO_2 per million parts air.

Maximum sulphur dioxide content of samples, 7.1 parts SO_2 per million parts air.

Range of results—

Range of results of determinations at station 2.

Limits of concentration (parts of SO_2 per million parts of air.	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	1,334	75.30
.2 to .4	130	7.32
.4 to .6	109	6.12
.6 to .8	71	4.00
.8 to 1.0	39	2.20
1.0 to 1.5	46	2.59
1.5 to 2.0	28	1.58
2.0 to 2.5	8	.45
2.5 to 3.0	2	.11
3.0 to 4.0	2	.11
4.0 to 5.0	2	.11
5.0 to 7.0	2	.11
	1,773	100.00

Thus, of the 1,773 samples taken at station 2, 1,334 (75.3 per cent) contained less than 0.2 parts SO_2 per million parts air; 1,464 (82.6 per cent) contained less than 0.4 part SO_2 per million parts air, and 94.9 per cent contained less than 1 part SO_2 per million parts air. The total number of samples that contained more than 2 parts SO_2 per million parts air was 16, or 0.9 per cent.

Summary of determinations made during definite periods of time.

Month or time.[a]	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
1913.		*Per cent.*		
September [b]	99	5.6	0.87	3.0
October	422	23.9	.42	7.1
November	286	16.1	< .20	1.1
1914.				
March	206	11.6	< .20	.2
April	537	30.2	< .20	1.0
May	223	12.6	.27	3.2
	1,773	100.0	.....	.....
4 to 8 a. m.	34	1.9	< .20	.6
8 a. m. to 12 m.	775	43.7	.22	7.1
12 m. to 6 p. m.	964	54.4	.27	5.5
	1,773	100.0	.....	.....

[a] Determinations were made as follows: September, 1913, A. E. Wells and G. N. Libby; October and November, 1913, H. L. Long; March, April, and May, 1914, H. H. Bartells.
[b] During September the tests at this station were made only at the times when the smoke was blown toward the station. Thus, the average of the September tests was naturally higher than that of the following months, which include determinations made under all conditions.

Summary of determinations made under certain wind and smoke conditions.

Condition of wind.[a]	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
Smoke drifting along path in angle COD or path OED	217	12.3	1.00	7.1
Smoke blown by high or moderate wind along path COD	144	8.1	.50	1.15
Smoke blown along straits or on Contra Costa Bluffs	761	43.0	< .20	.95
South or southwest wind; smoke along path in angle EOF	201	11.3	< .20	.4
Southeast or east wind	316	17.8	< .20	.25
Northeast or north wind	134	7.5	< .20	< .20
	1,773	100.0	.....	.....

[a] For "paths" referred to, see Plate VI.

DETAILED RESULTS.

The details of determinations are presented in the tabulation following.

Detailed results of determinations at station 2.

DETERMINATIONS MADE WHEN THERE WAS A VERY LIGHT WEST WIND; THE SMOKE BEING GENTLY BLOWN OR DRIFTED ALONG A PATH IN THE ANGLE COD,[a] OR ALONG THE PATH OED.[a]

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.	Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.				Average.	Maximum.	
1913.				*Tons.*	1913.				*Tons.*
Sept. 18	19	0.75	2.1	32	Oct. 27	11	1.10	1.6	40
22	21	1.05	2.0	26	28	10	2.40	7.1	40
26	39	1.15	3.0	17	Nov. 3	2	.50	1.0	19
Oct. 9	14	.60	1.0	11	22	6	.60	.9	36
10	7	1.10	1.4	21	1914.				
11	5	.55	.6	17	May 8	4	.70	1.0	36
14	28	.50	1.0	16	10	6	.90	1.0	38
16	10	.20	.4	2	11	7	1.70	3.0	45
17	6	.80	1.1	18	12	9	1.30	3.2	36
20	6	1.55	2.15	8					
21	5	2.40	4.3	16					
22	2	1.60	1.9	12		217	1.00	.....	.....

DETERMINATIONS MADE WHEN THERE WAS A MODERATE OR BRISK WEST WIND; THE SMOKE BEING BLOWN ALONG A PATH IN THE ANGLE COD,[a] OR ALONG THE PATH OED.[a]

1913.				*Tons.*	1914.				*Tons.*
Sept. 20	12	0.25	0.45	32	Apr. 2	5	0.70	1.00	23
Oct. 8	21	.70	1.10	11	25	1	.80	.80	29
10	5	.60	.80	21	26	5	.40	.60	27
13	18	.30	.70	14	May 1	2	.40	.40	27
15	16	.30	.50	14	6	2	.40	.60	41
23	10	.65	.95	12	8	4	.45	.60	36
24	4	.60	.75	13	10	2	.60	.80	38
29	17	.50	.95	38	12	5	.50	.60	36
30	2	.45	.60	16					
Nov. 10	1	1.10	1.10	33		144	.50	.....	.....
19	6	.30	.70	16					
21	6	.80	1.80	35					

DETERMINATIONS MADE WHEN THE WIND WAS DIRECT FROM THE WEST, AND THE SELBY SMOKE WAS BEING BLOWN ALONG STRAITS, SOUTH OF STATION.

1913.				*Tons.*	1914.				*Tons.*
Oct. 9	8	0.50	0.80	11	Apr. 10	17	<0.20	<0.20	27
10	12	.20	.40	21	13	10	< .20	< .20	27
17	9	.20	.30	18	14	20	< .20	< .20	20
20	6	.25	.30	8	15	20	< .20	< .20	16
21	14	.20	.55	16	16	12	< .20	< .20	17
27	7	.45	.65	40	17	4	< .20	< .20	21
28	14	.45	.95	40	20	6	< .20	< .20	27
29	4	.35	.35	38	22	20	< .20	< .20	21
30	3	.30	.30	18	23	19	< .20	< .20	33
Nov. 6	3	< .20	< .20	11	24	20	< .20	< .20	28
10	6	.20	.40	33	25	19	< .20	< .20	29
19	4	< .20	< .20	16	26	13	< .20	< .20	27
21	7	.30	.50	35	27	20	< .20	< .20	25
22	2	< .20	.20	36	28	20	< .20	< .20	21
					May 4	16	< .20	< .20	28
1914.					6	17	< .20	< .20	41
Mar. 18	10	< .20	< .20	26	8	12	< .20	< .20	35
20	11	< .20	< .20	24	9	18	< .20	< .80	25
21	10	< .20	< .20	31	10	11	< .20	< .20	38
23	5	< .20	< .20	19	11	14	< .20	< .20	45
24	7	< .20	< .20	18	12	6	< .20	< .20	36
26	12	< .20	< .20	22	13	18	< .20	< .20	22
27	20	< .20	< .20	28					
Apr. 7	19	< .20	< .20	27		437	.20	.....	.....
8	12	< .20	< .20	32					

[a] See Plate VI.

Detailed results of determinations at station 2—Continued.

DETERMINATIONS MADE WHEN THE WIND WAS NORTH OF WEST AND THE SELBY SMOKE WAS BLOWN ALONG THE BLUFFS ON THE OPPOSITE SHORE OF THE STRAITS.[a]

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.	Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.				Average.	Maximum.	
1913.				*Tons.*	1914.				*Tons.*
Oct. 22	14	<0.20	0.4	.....	Apr. 11	20	<0.20	<0.2	.....
23	9	< .20	< .2	.....	12	20	< .20	< .2	.....
24	13	< .20	< .2	.....	13	10	< .20	< .2	.....
25	5	< .20	< .2	.....	16	8	< .20	< .2	.....
Nov. 6	7	< .20	< .2	.....	May 1	17	< .20	< .2	.....
19	6	< .20	< .2	.....	2	16	< .20	< .2	.....
20	16	< .20	< .2	.....	5	20	< .20	< .2	.....
21	4	< .20	< .2	.....	7	18	.20	< .2	.....
22	5	< .20	< .2	.....					
28	6	< .20	< .2	.....		224	.....	.....	.....
29	10	< .20	< .2	.....					

[a] Total determinations made when the wind was blowing the smoke along a path included in the angle AOC (Pl. VI) include determinations made when the smoke was blown along the straits or along the Contra Costa shore, and equal 761.

DETERMINATIONS MADE WHEN THE WIND WAS FROM THE SOUTH OR SOUTHEAST AND THE SELBY SMOKE WAS BLOWN ALONG A PATH IN THE ANGLE EOF.[a]

1913.				*Tons.*	1914.				*Tons.*
Oct. 9	2	0.20	0.20	.....	Mar. 29	9	<0.20	<0.20	.....
15	8	< .20	.30	.....	30	13	< .20	< .20	.....
16	8	.20	.40	.....	Apr. 2	4	< .20	< .20	.....
17	1	.20	.20	.....	3	13	< .20	< .20	.....
29	2	< .20	.20	.....	6	18	< .20	< .20	.....
Nov. 10	4	< .20	.20	.....	9	9	< .20	< .20	.....
1914.					10	3	< .20	< .20	.....
Mar. 24	10	< .20	< .20	.....	17	8	< .20	< .20	.....
25	20	< .20	< .20	.....	20	11	< .20	< .20	.....
26	8	< .20	< .20	.....	21	20	< .20	< .20	.....
28	20	< .20	< .20	.....		201	.20	.....	.....

[a] See Plate VI.

DETERMINATIONS MADE WHEN THE WIND WAS FROM THE EAST OR SOUTHEAST.

1913.					1913.				
Sept. 18	5	<0.20	0.25	.....	Nov. 25	5	<0.20	<0.20	.....
20	3	< .20	.20	.....	26	12	< .20	< .20	.....
30	8	< .20	< .20	.....					
Oct. 31	14	< .20	< .20	.....	1914.				
Nov. 3	14	< .20	< .20	.....	Mar. 19	10	< .20	< .20	.....
4	16	< .20	< .20	.....	29	10	< .20	< .20	.....
5	21	< .20	< .20	.....	30	7	< .20	< .20	.....
6	7	< .20	< .20	.....	31	19	< .20	< .20	.....
7	17	< .20	< .20	.....	Apr. 1	20	< .20	< .20	.....
10	4	< .20	< .20	.....	2	12	< .20	< .20	.....
11	18	< .20	< .20	.....	4	15	< .20	< .20	.....
12	10	< .20	< .20	.....	8	8	< .20	< .20	.....
14	13	< .20	< .20	.....	17	8	< .20	< .20	.....
17	14	< .20	< .20	.....	18	17	< .20	< .20	.....
19	1	< .20	< .20	.....					
24	8	< .20	< .20	.....		316	< .20	.....	.....

DETERMINATIONS MADE WHEN THE WIND WAS FROM THE NORTH OR NORTHEAST.

1913.					1914.				
Sept. 11	19	<0.20	<0.20	.....	Mar. 23	5	<0.20	<0.20	.....
Oct. 15	2	< .20	< .20	.....	Apr. 29	20	< .20	< .20	.....
17	5	< .20	< .20	.....	30	20	< .20	< .20	.....
18	16	< .20	< .20	.....					
19	16	< .20	< .20	.....		134	< .20	.....	.....
20	6	< .20	< .20	.....					
Nov. 8	16	< .20	< .20	.....					
13	5	< .20	< .20	.....					
15	4	< .20	< .20	.....					

At times it was difficult to tell the exact conditions under which the tests were made, especially after the bag house was operating and the smoke was cleared from solids. Frequently the wind apparently was blowing the smoke in a direct line from the smokestack to the station, yet at the station only a slight trace, sometimes none, of sulphur dioxide was found. At other times the smoke apparently was blown along the straits to the south of the station, yet an appreciable quantity of sulphur dioxide was determined at the station.

DISCUSSION OF DETERMINATIONS MADE AT STATION 2, WHEN SMOKE WAS BEING BLOWN BY A VERY LIGHT WEST WIND OR DRIFTING ALONG A PATH INCLUDED IN THE ANGLE COD OR FOLLOWING THE LINE OED ALONG THE BLUFFS ON NORTH SIDE OF STRAITS.[a]

Ninety-two of the 217 samples taken under these conditions were taken when the smoke was observed in the immediate vicinity. The data of these 92 tests are given below. Also, are given the data of the 8 samples taken when the sulphur dioxide was detected by smell.

Determinations made at times when the Selby smoke was observed by vision or by smell in the immediate vicinity.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.	Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.				Average.	Maximum.	
1913.				*Tons.*	1914.				*Tons.*
Sept. 18	6	1.15	2.1	32	Apr. 2	5	0.70	1.0	24
22	11	1.40	1.8	26	May 8	4	.80	1.0	36
26	18	1.75	3.0	17	10	6	.90	1.0	38
Oct. 8	2	1.40	1.45	11	11	7	1.70	3.0	45
17	2	.85	1.1	18	12	9	1.30	3.2	36
20	6	1.55	2.15	8					
21	3	3.30	4.3	16		92	1.50	7.1	.....
28	4	4.15	7.1	40					
29	1	1.55	1.55	38					
Nov. 3	2	1.00	1.1	19					
22	6	.60	.9	36					

Determinations made when the Selby smoke was smelled at station 2.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.	Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.				Average.	Maximum.	
1913.				*Tons.*	1914.				*Tons.*
Sept. 26	1	3.00	3.0	17	May 12	1	3.20	3.2	36
Oct. 21	3	3.40	4.3	16					
28	3	5.70	7.1	40		8	.....	.....	.....

[a] See Plate VI.

The data obtained on certain days when the maximum contamination of the atmosphere in the vicinity of the station was found, and the most unfavorable wind conditions existed, are given below for further study.

SEPTEMBER 18, 1913.

Smelter data.

Number of sintering machines in operation, 3.
Rate of sulphur elimination, 32 tons per 24 hours.
Wind record at smelter, southwest wind; velocity one-half mile per hour.

Station 2 data.

The results of tests made by A. E. Wells and G. N. Libby were as follows:

Results of sampling at station 2, September 18, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.[a]
p. m.		
2.10	0.4	Selby smoke drifting on line OED.[b]
2.20	.6	Selby smoke drifting on line OED; slight oil smell at station.
2.30	.6	Slight oil smell at station.
2.40	.4	No smell.
3.00	.4	Slight oil smell.
3.10	.3	Do.
3.40	1.0	Selby smoke drifting on line OED; hazy; slight oil smell.
4.00	.4	Selby smoke drifting on line OE; less hazy; slight oil smell.
4.10	.3	Slight haze; slight oil smell.
4.15	.6	Selby smoke drifting on line OED up to Glen Cove.
4.22	2.1	Selby smoke visible around station.
4.30	1.7	Do.
4.35	1.4	Selby smoke clearing around station.
4.40	.9	Clearer around station.
4.50	.8	Wind slightly stronger.
5.00	.9	Wind strong.
5.10	.7	
5.20	.5	
5.35	.3	
	.75	

[a] At no time did the smoke appear to rise over the bluffs north of the straits, or to go north of Glen Cove resort. The line of drift was essentially along OED (Pl. VI).
[b] See Plate VI.

SEPTEMBER 26, 1913.

Smelter data.

Number of sintering machines in operation, 2.
Rate of sulphur elimination, 17 tons per 24 hours.
Wind record at smelter, 7 a. m. to 3 p. m., west; velocity 3 miles per hour.

Station 2 data.

The results of tests at station 2 made by A. E. Wells and G. M. Libby were as follows:

Results of sampling at station 2, September 26, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.[a]
a. m.		
8.10	0.8	Slight smell of oil vapors.
8.20	.4	Do.
8.30	1.0	Distinct smell of oil vapors.
8.40	1.5	Strong and nauseating smell of oil fumes.
8.50	1.2	Do.
8.55	.6	Slight smell oil vapors.
9.15	1.0	No smell of oil vapors.
9.30	.5	Slight westerly breeze.
9.45	.6	Do.
10.00	1.5	Hazy around station; smoke.
10.15	1.9	Do.
10.30	1.6	Do.
10.45	1.7	Hazy around station; oil smell.
10.55	1.2	Do.
11.10	1.6	Do.
11.25	2.5	Smoke puffs passing station; no smell.
11.35	1.3	Hazy, but no puffs.
11.55	.5	Smoke on channel south of station.
p. m.		
12.20	1.2	Smoke again headed to station.
12.30	1.9	Slight westerly wind; smoky in Glen Cove.
12.45	2.9	Smoke puffs passing station; slight smell of SO_2.
12.55	2.4	Smoke puffs passing station; no smell of SO_2.
1.10	.9	Slight west wind clearing around station.
1.20	.7	Do.
1.35	.5	Clear.
1.50	1.0	Smoke drifting in; slight haze in Glen Cove.
2.05	.9	Haze.
2.15	1.2	Do.
2.25	1.7	Smoke drifting around station; slight oil smell.
2.35	2.0	Smoke drifting around station; strong oil smell.
2.45	2.0	Do.
3.00	1.3	Smoke drifting around station; slight oil smell.
3.15	1.8	Smoke drifting around station; no smell.
3.30	1.3	Wind freshening, clearing air; no smell.
3.45	.4	Wind stronger; clear at station.
4.10	$<$ .2	Wind blowing smoke along straits.
4.40	$<$ .2	
4.55	$<$ .2	
5.15	$<$ .2	

[a] Smoke was drifting in angle COD (Pl. VI) toward the station all day; hence the dissipation of SO_2 by dispersion was reduced to a minimum. These data, consequently, represent the worst conditions.

October 21, 1913.

Smelter data.

Number of sintering machines in operation, 2.

Rate of sulphur elimination, 16 tons per 24 hours.

Wind record at smelter, west or southwest: velocity 3 miles per hour.

Station 2 data.

The results of tests made at station 2 by H. L. Long were as follows:

Results of sampling at station 2, October 21, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.[a]
p. m.		
1.35	0.3	Smoke drifting along straits south of station.
1.40	.1	Do.
1.50	4.3	Smoke puffs drifting past station; smell SO_2.
2.00	.4	Smoke back along straits.
2.25	2.3	Smoke puffs drifting past station; smell SO_2.
2.40	1.3	Smoke shifting back to straits.
3.10	.5	Smoke drifting up channel.
3.30	.3	Do.
3.45	.9	Smoke coming toward station.
3.55	3.6	Smoke drifting past station.
4.00	.2	Smoke over straits.

OCTOBER 28, 1913.

Smelter data.

Number of sintering machines in operation, 2.
Rate of sulphur elimination, 40 tons per 24 hours.
Wind record at smelter, west wind; velocity 7 miles per hour.

Station 2 data.

The results of tests made by H. L. Long at station 2 were as follows:

Results of sampling at station 2, October 28, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.
a. m.		
9-10.45	[a] 0.3	Smoke along straits.
11.15	7.1	Smoke drifting to station; smell SO_2.
11.30	4.8	
11.45	1.9	Smoke drifting to station and along straits.
p. m.		
12.05	1.0	
12.15	2.1	
12.35	5.5	Smoke drifting to station; smell SO_2.
12.45	1.2	Smoke drifting to station and along straits.
1.15	.8	
1.40	.4	
2.15	1.9	
2.45	.9	Smoke drifting along straits.
3.15	.9	

[a] Average.

MAY 11, 1914.

Smelter data.

Number of sintering machines in operation, 3.
Ropp roaster operating.
Rate of sulphur elimination, 45 tons per 24 hours.
Wind record at smelter, southwest; velocity, 4 to 5 miles.

Station 2 data.

Results of sampling at station 2, May 11, 1914.

Time.	Parts of SO_2 per million parts of air.	Notes.
5 a.m. to 12.30 p. m.	[a] <0.2	Smoke along Contra Costa shore.
p. m.		
1.00	1.2	Smoke drifting to station.
1.20	3.0	Smoke drifting to station; no smell.
1.40	1.8	Smoke clearing locally.
2.00	1.6	Smoke along straits.
2.30	1.6	Smoke drifting toward Glen Cove.
3.00	1.8	Smoke along straits, on line OE. [b]
3.15	.4	Smoke along straits; wind brisker.

[a] Average. [b] See Plate VI.

MAY 12, 1914.

Smelter data.

Number of sintering machines in operation, 3.
Ropp roaster in operation.
Rate of sulphur elimination, 38 tons per 24 hours.
Wind record at smelter, southwest; velocity, 4 to 5 miles.

Station 2 data.

Results of sampling at station 2, May 12, 1914.

Time.	Parts of SO_2 per million parts of air.	Notes.
a. m.		
11.00	<0.20	Smoke going southeast along straits.
11.30	.60	Smoke drifting to station.
m.		
12.00	1.20	Smoke around station.
p. m.		
12.20	3.20	Smoke around station; SO_2 smelled.
12.45	1.60	Smoke around station; clearing slightly.
1.10	.80	Smoke clearing at station; strong oil smell.
1.35	1.00	Smoke all over straits and vicinity.
2.00	1.20	Do.
2.30	1.00	Smoke along straits.
3.00	1.00	Do.
3.30	.80	Do.
4.00	.60	Smoke along line OED [a]
4.30	< .20	Smoke going along Contra Costa shore.
5.00	< .20	Do.

[a] See Plate VI.

As a marked contrast to the data of October 28, we have the data of October 29, when the sulphur elimination for the stack was practically the same. On October 28 the smoke was drifting over toward the station, and on October 29 was blown to that point by a moderate or high west wind. Under the conditions of October 29, dispersion as well as diffusion aided in the dissipation of the sulphur dioxide.

OCTOBER 29, 1913.

Smelter data.

Number of sintering machines in operation, 2.
Ropp roasters in operation, 1.
Rate of sulphur elimination, 38 tons per 24 hours.
Smelter wind records, southwest; velocity, 12 miles per hour.

Station 2 data.

Results of sampling at station 2, October 29, 1913.

Time.	Parts of SO_2 per million parts of air.	Notes.
a. m.		
10.25	0.6	Smoke blown direct to station.
10.45	.5	
11.10	.3	
11.35	<.2	
11.50	<.2	
p. m.		
12.20	.2	
12.45	.3	
1.30	.9	
1.45	.8	
2.15	.4	
2.45	.2	
3.10	.6	
3.30	.9	
4.00	.5	
4.35	.2	
4.50	.4	

The approximate periods of time certain concentrations were present in the air at station 2 were as follows:

Approximate periods certain proportions of SO_2 were present in air at station 2.

Parts of SO_2 per million parts of air.	Period.	Proportion of total sampling time.
	Minutes.	*Per cent.*
5.0 to 7.5	35	0.08
>3.0	65	.14
>2.0	180	.40
>1.0	1,220	2.70
>0.5	3,330	7.40

The approximate periods of time that certain concentrations were present in the air at station 2 on different days were as follows:

1. Between 5 and 7.5 parts of SO_2 per million parts of air:

Date.	Length of time (minutes per period).
Oct. 28	25
	10
Total	35

2. More than 3 parts of SO_2 per million parts of air:

Date.	Length of time (minutes per period).
Oct. 20	10
Oct. 21	5
Oct. 28	25
	10
May 12	15
Total	65

3. More than 2 parts of SO_2 per million parts of air:

Date.	Length of time (minutes per period).
Sept. 18	5
Sept. 22	10
	25
	10
Oct. 20	10
Oct. 21	20
	15
Oct. 28	25
	25
May 11	20
May 12	15
Total	180

4. More than 1 part of SO_2 per million parts of air:

Date.	Length of time (minutes per day)
Sept. 18	20
Sept. 22	115
Sept. 26	315
Oct. 8	25
Oct. 10	60
Oct. 17	5
Oct. 20	60
Oct. 21	45
Oct. 22	20
Oct. 27	120
Oct. 28	120
Oct. 29	10
Nov. 10	15
Nov. 19	20
May 11	120
May 12	120

5. More than 0.5 part of SO_2 per million parts of air:

Date.	Length of time (minutes per day).
Sept. 18	95
Sept. 22	235
Sept. 26	420
Oct. 8	195
Oct. 9	120
Oct. 10	140
Oct. 11	60
Oct. 13	30
Oct. 14	200
Oct. 17	20
Oct. 20	70
Oct. 21	60
Oct. 22	20
Oct. 23	180
Oct. 24	60
Oct. 27	250
Oct. 28	240
Oct. 29	75
Oct. 30	10
Nov. 3	30
Nov. 10	15
Nov. 19	15
Nov. 21	25
Nov. 22	50
Apr. 2	60
Apr. 25	10
Apr. 26	15
May 6	15
May 8	90
May 10	200
May 11	130
May 12	200
Total	3,330

DETERMINATIONS MADE IN THE COVES WEST OF STATION 2, COMPRISING GLEN, ELLIOTT, AND DOS REIS COVES.

GENERAL SUMMARY.

Total number of samples taken, 95.

Average sulphur dioxide content of samples, 0.20 part of SO_2 per million parts of air.

Maximum sulphur dioxide content of samples, 2.25 parts of SO_2 per million parts of air.

Range of results—

Range of results of determinations made in the coves west of station 2.

Limits of concentration (parts SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	68	71.7
.2 to .4	10	10.5
.4 to .6	10	10.5
.6 to .8	2	2.1
.8 to 1.0	1	1.0
1.0 to 1.5	3	3.2
1.5 to 2.0	0	.0
2.0 to 2.5	1	1.0
	95	100.0

Summary of determinations made within certain time limits.[a]

Month or time.	Number.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
September	31	32.6	0.30	1.4
October	31	32.6	<.20	.2
November	.....	.....	.....	.....
March	.....	.....	.....	.....
April	9	9.5	<.20	.25
May	24	25.3	.30	2.25
	95	100.0	.....	.....
4 a. m. to 8 a. m.	7	7.4	.20	.4
8 a. m. to 12 m.	19	20.0	.50	2.25
12 m. to 6 p. m.	69	72.6	<.20	1.4
	95	100.0	.....	.....

[a] Determinations were made as follows: In September, 1913, by A. E. Wells; in October, 1913, by G. N. Libby; in April and May, 1914, by H. L. Long.

Summary of determinations made under certain wind conditions.

Condition of wind.[a]	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
Slight west wind; smoke in path COD	4	4.2	1.30	2.25
Moderate or strong west wind; smoke angle, COD	25	26.3	.25	1.40
Smoke along straits in path AOC	.....	.....	.....	.....
South or southeast wind; smoke in path EOF	38	40.0	<.20	.5
East or southeast wind	.....	.....	.....	.....
North of northeast wind	2	2.1	<.20	.2
Northwest wind	26	27.4	<.20	.2
	95	100.0	.....	.....

[a] For "paths" referred to see Plate VI.

DETAILED RESULTS.

A tabulation showing detailed results is given herewith.

Detailed results of determinations made in vicinity of Glen, Elliott, and Dos Reis Coves.

DETERMINATIONS MADE WHEN THE SMOKE WAS FROM THE WEST AND WAS LIGHT. CAUSING THE SMOKE TO DRIFT ALONG A PATH IN THE ANGLE COD.[a]

Date.	Place.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter for 24 hours.
			Average.	Maximum.	
1914.					*Tons*
Apr. 10	Glen Cove	4	1.30	2.25	38

[a] See Plate VI.

MODERATE OR BRISK WEST WIND.

1913.					
Sept. 19	Glen Cove	14	0.50	1.40	31
Sept. 24	do	3	.40	.50	22
1914.					
May 3	do	3	<.20	.25	26
May 9	do	5	<.20	.50	25
		25	.26		

WIND FROM THE SOUTH OR SOUTHWEST.

1913.					
Sept. 25	Dos Reis Cove	6	0.40	0.5	26
Oct. 13	do	11	<.20	<.2	14
1914.					
Apr. 30	do	9	<.20	.25	26
May 9	Glen Cove	3	<.20	<.20	25
May 10	do	5	<.20	.50	38
May 11	Dos Reis Cove	4	<.20	.25	45
		38	<.20		

WIND FROM THE EAST OR SOUTHEAST.

No determinations.

WIND FROM THE NORTH OR NORTHEAST.

1913.					
Sept. 23	Glen Cove	2	<0.20	0.20	

WIND FROM THE NORTHWEST.

1913.					
Sept. 26	Glen Cove	4	<0.20	0.20	
Sept. 24	Elliott Cove	2	<.20	.20	
Oct. 30	do	8	<.20	.20	
1914.					
May 5	Dos Reis Cove	12	<.20	<.20	
Total		26			
		95			

DETAILS OF DETERMINATIONS MADE MAY 10, 1914, WHEN MAXIMUM CONCENTRATIONS WERE FOUND.

The results of determinations made May 10, 1914, when the maximum concentrations were obtained, are given below.

Place of sampling, Glen Cove resort.
Number of sintering machines in operation, 3.
Ropp roaster in operation on ore.
Rate of sulphur elimination, 38 tons per 24 hours.
Wind record at smelter, southwest; velocity, 1 mile.

Results of determinations made near Glen, Elliott, and Dos Reis Coves on May 10, 1914.[a]

Time.	Parts of SO_2 per million parts of air.	Notes.
a. m.		
11.30	1.0	Very light breeze.
11.45	1.2	Directly from smelter.
m.		
12.00	2.25	Smoke puffs visible passing over Glen Cove.
p. m.		
12.15	<.25	Stronger breeze clearing air.

[a] Determinations made by H. L. Long.

DETERMINATIONS MADE ALONG THE VALLEJO-BENICIA ROAD, BETWEEN BENICIA CITY LIMITS AND CARQUINEZ CEMETERY.

GENERAL SUMMARY.

Total number of samples, 111.

Average sulphur dioxide content of samples, 0.22 part of SO_2 per million parts of air.

Maximum sulphur dioxide content of samples, 2.60 parts of SO_2 per million parts of air.

Range of results—

Range of results of determinations made along the Vallejo-Benicia Road between Benicia city limits and Carquinez Cemetery.

Limits of concentration (parts of SO_2 per million parts of air.	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	92	82.9
.2 to .4	4	3.6
.4 to .6	6	5.4
.6 to .8	2	1.8
.8 to 1.0	1	.9
1.0 to 1.5	1	.9
1.5 to 2.0	1	.9
2.0 to 2.5	3	2.7
2.5 to 3.0	1	.9
	111	100.0

Summary of determinations made during certain time limits.[a]

Month or time.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
1913.		*Per cent.*		
September	17	15.3	0.80	2.6
October	31	27.9	.20	.9
November	47	42.4	<.20	.6
1914.				
March				
April	6	5.4	<.20	.2
May	10	9.0	<.20	.75
	111	100.0		
4 a. m. to 8 a. m.				
8 a. m. to 12 m.	27	24.3	<.20	.9
12 m. to 6 p. m.	84	75.7	.25	2.6

[a] Determinations were made as follows: In September, October, and November, 1913, by G. N. Libby; in April and May, 1914, by H. L. Long.

Summary of determinations made under certain wind conditions.

Condition of wind.	Number of determinations.	Proportion of total.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
		Per cent.		
Slight west wind; smoke in path COD[a]	79	63.1	0.30	2.6
Moderate or brisk west wind; smoke in path COD[a] or along straits	17	15.3	<.20	.25
South or southwest wind	7	14.4	<.20	.25
East or southeast wind				
North or northeast wind	8	7.2	<.20	<.20
Northwest wind				
	111	100.0		

[a] See Plate VI.

DETAILED RESULTS.

Detailed results of the determinations are tabulated below.

Detailed results of determinations made along the Vallejo-Benicia Road between the Benicia city limits and Carquinez Cemetery.[a]

WIND FROM WEST AND LIGHT, CAUSING THE SELBY SMOKE TO DRIFT ALONG A PATH INCLUDED IN THE ANGLE COD.[b]

Date.	Place.	Number of tests.	Parts of SO_2 per million parts of air.[a]		Rate of sulphur elimination from smelter for 24 hours.
			Average.	Maximum.	
1913.					*Tons.*
Sept. 24	Near Corcoran's ranch	3	<0.20	0.20	22
Sept. 30	At Rose's house	6	2.00	2.60	15
Oct. 8	Near Corcoran's ranch	6	.30	.50	11
Oct. 10	At Brazil's house	14	.20	.90	18
Nov. 3	Midway saloon	17	<.20	.20	19
Nov. 6	At Brazil's house	23	<.20	.20	11
Nov. 9	Near Corcoran's ranch	7	<.20	.60	10
1914.					
May 10	Midway saloon	3	.50	.75	38
		79	.30		

[a] Determinations made by G. N. Libby. [b] See Plate VI.

Detailed results of determinations made along the Vallejo-Benicia Road between the Benicia city limits and the Carquinez Cemetery—Continued.

MODERATE OR BRISK WEST WIND.

Date.	Place.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter for 24 hours.
			Average.	Maximum.	
1913.					*Tons.*
Oct. 3	At Rose's house	11	0.20	0.25	16
1914.					
Apr. 25	Midway saloon	3	.20	.20	29
May 11	do	3	.20	.25	45
		17	.20		

SOUTH OR SOUTHWEST WIND.

1914.					
Apr. 3	Midway saloon	3	<0.20	<0.20	27
May 9	do	2	< .20	.25	25
May 12	do	2	< .20	< .20	22
		7	< .20		

EAST OR SOUTHEAST WIND.

No determinations.

NORTH OR NORTHEAST WIND.

1913.					
Sept. 30	At Rose's house	8	0.20	0.20	

RESULTS OF DETERMINATIONS MADE AT THE ROSE HOUSE, SEPTEMBER 30, 1913.

The data of September 30 at the Rose house, where the maximum concentrations in these limits were obtained, are given below:

SEPTEMBER 30, 1913.

Number of sintering machines in operation, 2.
Rate of sulphur elimination, 15 tons per 24 hours.
Wind record at smelter—
Before 3.00 p. m., southeast wind.
After 3.00 p. m., west wind.
Velocity of wind, 4 miles per hour.

Results of determinations made at Rose's house, Sept. 30, 1913.[a]

Time.	Parts of SO_2 per million parts of air.	Notes.[a]
11.30 a. m. to 3.30 p. m.	<0.20	Wind from northeast until 3.30 p. m.
3.50 p. m.	2.20	Slight southwest wind; strong oil smell.
3.55 p. m.	2.60	Do.
4.00 p. m.	1.30	Slight southwest wind; slight oil smell.
4.05 p. m.	2.10	Do.
4.15 p. m.	2.00	Do.
4.30 p. m.	1.70	Do.
4.40 p. m.	.50	Moderate southwest wind; no smell.

[a] Determinations made by G. N. Libby.

DETERMINATIONS MADE ALONG THE VALLEJO-BENICIA ROAD BETWEEN THE CARQUINEZ CEMETERY AND THE VALLEJO CITY LIMITS.

The details of determinations made along the Vallejo-Benicia Road between the Carquinez Cemetery and the Vallejo city limits are tabulated below.

Details of determinations made along Vallejo-Benicia Road between Carquinez Cemetery and Vallejo city limits.

Date.	Number of tests.	Parts of SO_2 per million parts of air.		Rate of sulphur elimination from smelter per 24 hours.
		Average.	Maximum.	
				Tons.
Nov. 5	25	<0.20	1.00	19
Nov. 17	7	< .20	.20	17
Apr. 30	10	< .20	.20	26
	42			

During September, October, and November, 1913, the smoke drifted along the path COD or OEF (Pl. VI) more often than in the spring months. During the spring months the wind was from the west and the smoke was carried along the straits to the south of Dillon Point much more often than during the fall. Thus, during the fall months the sulphur dioxide concentration in the air of the agricultural district was greater than in the spring months.

COMPARISON OF DETERMINATIONS MADE SIMULTANEOUSLY IN DIFFERENT PARTS OF THE "SMOKE ZONE."

For the purpose of comparing the sulphur dioxide content of the atmosphere in different parts of the "smoke zone" at a time when the wind was from the west, Table 9 following has been prepared. In this table is given the sulphur elimination from the smelter as determined by calculation and by actual analysis and measurement of the gases leaving the stack.

In most cases where samples were taken simultaneously at two or more points in the path of the smoke stream, a decrease in the sulphur dioxide content of the samples was noted at the point of greatest distance from the smelter. However, due to the great variations caused by local wind currents, it is impossible to determine a ratio of decrease in concentration of sulphur dioxide which could be used as a factor for calculating concentrations at various points.

It should be noted that, during the spring months when the smoke was being blown by a fairly light or moderate west wind directly along the straits in path AOC (Pl. VI), the air at station 2, which was slightly out of the path of the smoke stream, was practically free from sulphur dioxide, while at station 1, in the direct path of the smoke stream, the air contained determinable quantities.

Table 9 follows.

TABLE 9.—*Results of SO_2 determinations made simultaneously*

Date.	Time.	Quantity of sulphur from stack per 24 hours.		General data regarding wind—							
				At smelter.		At station 2.		At station 1.		At automobile laboratory station.	
		Calculated from daily metallurgical reports.	Calculated from analytical data obtained at stack.	Direction.	Velocity, miles per hour.	Direction.	Degree.	Direction.	Degree.	Direction.	Degree.
1913.		*Tons.*	*Tons.*								
Oct. 8	11.45-1.30	11	.....	SW...	12	W....	Moderate	.....	.....	S. of W	Moderate
9	8.30-1.30	11	.....	Calm..	.....	.....	.....	.....	.....	W....	Slight...
				W....	4	W....	Slight.				
10	11.30-4.30	21	.....	Calm..	.....	.....	.....	.....	.....	SW...	...do....
				SW...	5	W....	Slight.				
14	8.30-4.30	16	18	W....	4	W....	...do....	W.....	.....	W....	...do....
				SW...	6	.....	.....	SW....	Slight.		
				SW...	6						
15	10.00-1.00	14	12	SW...	4	SW and W.	Slight...	W.....	...do..	W....	...do....
16	9.00-3.00	2	2	Calm..	.....	.....	.....	.....	.....	W....	...do....
				SW...	6	W....	Slight...	W.....	Slight.		
17	7.30-4.30	18	12	Calm..	.....	W....	...do....	W.....	...do..	W....	...do....
				SW...	½						
				Calm.							
20	2.30-5.00	8	.....	Calm..	.....	W....	...do....	W.....	...do..	W....	...do....
				SW...	2						
				Calm.							
21	11.00-4.00	16	16	W....	2	W....	...do....	W.....	...do..	W....	Brisk...
				SW...	4						
22	8.00-4.00	12	11	Calm..	.....	W....	...do....	W.....	...do..	W....	Slight...
				Calm and SW.							
23	12.00-3.00	12	.....	W....	5	W....	...do....	W.....	...do..	W....	...do....
25	11.00-2.00	9	10	SW...	3	.....	.....	W.....	...do..	W....	...do....
				Calm.							
27	9.00-1.00	40	36	Calm..	.....	Slight.	.....	.....	.....	.....	.....
				Calm..	.....	N. of W	Slight...	N. of W.	Slight.	N. of W	Slight.
				Calm..							
	1.00-4.00	40	39	Calm..	.....	.....	.....	.....	.....	.....	.....
				Calm..	.....	W....	Slight...	W.....	Slight.	W....	Slight.
28	9.00-11.00	40	36	Calm..	.....	Slight.	.....	.....	.....	W....	...do....
				W....	6	N. of W	Slight...	W.....	Slight.		
	11.00-3.00	40	41	W....	6	W....	...do....	W.....	...do..	W....	...do....
29	9.00-3.30	37	36	SW...	8	.....	.....	.....	.....	W....	Strong..
					25	S.....	Strong..	W.....	Strong.		
					30						
30	1.40-2.40	16	18	SW...	15	W....	...do....	W.....	...do..	N.....	...do....
Nov. 3	2.00-3.30	38	38	SW...	9	W....	Slight...	W.....	Slight.	W....	Slight...
											Calm.
4	8.00-4.00	17	15	Calm..	.....	.....	.....	.....	.....	Calm..	.....
				SW...	5	Calm..	.....	Calm.			
10	10.45-4.00	33	35	SW...	9	W....	Moderate	W.....	Moderate.	.....	.....
					6						
19	12.30-1.00	16	.....	SW...	7	W....	...do....	W.....	...do..	W....	Moderate
21	10.00-2.00	35	36	Calm..	.....	W....	Slight...	W.....	Slight.	W....	Slight...
22	11.00-2.30	36	31	W....	5	W....	...do....	W.....	...do..	W....	...do....
1914.											
Mar. 21	12.00-4.00	31	.....	W....	14	W....	Strong..	W.....	Strong.	.....	.....
23	10.00-1.00	18	.....	SW...	6	W....	...do....	W.....	...do..	.....	.....
25	12.00-5.00	21	.....	W....	9	SW...	...do....	W.....	...do..	.....	.....
26	9.30-5.00	22	.....	W....	12	NW...	...do....	.....	.....	.....	.....
				SW...	10	SW...	...do....	W.....	Strong.		
27	8.00-5.00	28	.....	W....	10	SW...	...do....	.....	.....	.....	.....
					12	NW...	...do....	W.....	Strong.		

* See Plates VI and VII.

in different parts of "smoke zone." [a]

General notes regarding smoke.	Data regarding SO_2.									
	Station 2.			Station 1.			Automobile laboratory station.			
	Number of tests.	Parts of SO_2 per one million parts of air.		Number of tests.	Parts of SO_2 per one million parts of air.		Place.	Number of tests.	Parts of SO_2 per one million parts of air.	
		Average.	Maximum.		Average.	Maximum.			Average.	Maximum.
Blowing toward station 2	5	0.90	1.15	.....	.....	.....	Corcoran's ranch..	5	0.35	0.50
.....do.....	15	.60	1.00	.....	.....	.....	Anderson Hotel...	12	<.20	<.20
Drifting up channel of straits; angle AOC.	15	.40	.80	5	1.00	2.40	Shipyard.....	9	<.20	<.20
Blown along straits and to station.	28	.50	1.00	20	<.20	.20	Road to Passalacqua's house.	22	.40	1.00
Blown along straits to Benicia.	11	.30	.50	8	.20	.80	East of schoolhouse.	9	.20	.40
Drifting to White's and along straits.	18	<.20	.40	19	<.20	.20	Passalacqua's house.	18	<.20	<.20
Drifting around smelter and up straits.	16	<.20	1.00	21	<.20	.40	Prince's, K Street.	22	<.20	.40
Drifting past north tower into Benicia.	9	1.10	2.20	8	.60	1.60	City wharf.....	12	<.20	.20
Blown along straits or thick around north tower.	12	1.10	4.30	12	<.20	.30	Cemetery north of Benicia.	10	<.20	.20
Blown along straits and Contra Costa shore.	16	.25	1.90	24	<.20	.20	Eben Selby's house.	17	.30	.50
Drifting along straits and to station 2.	5	.80	.90	7	<.20	.20	Arsenal.....	10	<.20	.20
Drifting up straits; oil smell at Benicia.	.....	.....	.....	9	<.20	.20	Shipyard.....	10	.30	.80
Heavy along straits close to Contra Costa shore.	7	.50	.60	10	.30	.40	Dana Place.....	10	<.20	<.20
Drifting up straits close to north tower; path AOC.	11	1.10	1.60	12	.80	1.90	.....do.....	9	.70	1.10
Heavy along straits close to Contra Costa shore.	7	.40	.80	6	.20	.20	Catholic cemetery.	6	<.20	.40
Heavy along straits close to north tower; path AOC.	11	1.40	7.10	14	.50	1.50	.....do.....	15	<.20	.20
Scattered over straits and toward north tower.	16	.40	.90	16	<.20	.30	Carty's place.....	17	<.20	.40
Coming up straits.....	2	.40	.60	5	.40	.80	Elliott Cove.....	4	<.20	<.20
Drifting along straits; path COD.	4	.75	1.00	4	<.20	.20	Midway saloon....	5	<.20	<.20
Hovering at smelter.....	16	<.20	.20	26	<.20	.20	Near road to Fisher's.	13	<.20	<.20
Drifting up straits; path AOC.	14	.20	1.10	14	.45	.90	Anderson Hotel...	2	.20	.20
Going up straits; path AOC.	2	.25	.30	2	.30	.40	.....do.....	2	.20	.20
Up straits and to north tower.	12	.55	1.80	13	.20	.50	.....do.....	10	<.20	.40
Drifting up straits and to north tower.	6	.60	.90	8	.25	.50	Tannery.....	9	.20	.70
Blown along straits; path AOC.	5	<.20	<.20	9	<.20	<.20	.....	.....	.....	.....
Path AOC.....	4	<.20	<.20	5	.20	.60	.....	.....	.....	.....
.....do.....	11	<.20	<.20	14	.30	1.00	.....	.....	.....	.....
.....do.....	17	<.20	<.20	19	.20	.35	.....	.....	.....	.....
.....do.....	20	<.20	<.20	23	.20	.35	.....	.....	.....	.....

TABLE 9.—*Results of SO_2 determinations made simultaneously*

Date.	Time.	Quantity of sulphur from stack per 24 hours.		General data regarding wind—							
				At smelter.		At station 2.		At station 1.		At automobile laboratory station.	
		Calculated from daily metallurgical reports.	Calculated from analytical data obtained at stack.	Direction.	Velocity, miles per hour.	Direction.	Degree.	Direction.	Degree.	Direction.	Degree.
1914.		*Tons.*	*Tons.*								
Apr. 3	2.00-5.00	27	.....	W	2	.....	.....	.....	.....	.....	.....
				SW	4	SW	Slight	W	Slight.	W	Slight.
6	10.00-2.00	28	.....	W	7	.....	.....	.....	.....	.....	.....
				SW	8	W	Slight	W	Slight.	.....	.....
7	8.00-2.00	27	.....	W	5	.....	.....	.....	.....	.....	.....
					4	W	Slight	W	Slight.	.....	.....
8	8.00-1.00	33	.....	SW	5	.....	.....	.....	.....	.....	.....
					7	SW	Slight	W	Slight.	W	Slight.
10	10.00-4.00	27	.....	W	7	.....	.....	.....	.....	.....	.....
					14	W	Strong	W	Strong.	.....	.....
11	9.00-11.00	28	.....	W	7	.....	.....	.....	.....	.....	.....
				SW	5	W	Slight	W	Slight.	.....	.....
13	8.00-2.30	27	.....	W	7	.....	.....	.....	.....	.....	.....
					5	W	Moderate	W	Moderate.	.....	.....
14	8.00-2.00	20	.....	SW	8	.....	.....	.....	.....	.....	.....
					6	W	Moderate	W	Slight.	.....	.....
15	2.00-5.00	16	.....	SW	12	W	Strong	W	Strong.	.....	.....
16	2.00-5.00	17	.....	SW	5	.....	.....	.....	.....	.....	.....
				W	6	W	Strong	W	Strong.	W	Strong.
20	3.00-4.30	27	.....	W	10	.....	.....	.....	.....	.....	.....
				SW	8	W	Strong	W	Strong.	.....	.....
22	8.00-5.00	21	.....	SW	12	.....	.....	.....	.....	.....	.....
					11	W	Strong	W	Strong.	.....	.....
23	8.00-4.30	33	.....	SW	8	.....	.....	.....	.....	.....	.....
					12	W	Strong	SW	Strong.	.....	.....
24	8.00-3.00	28	.....	SW	6	.....	.....	.....	.....	.....	.....
					8	W	Strong	W	Strong.	.....	.....
25	8.00-4.00	29	.....	W	8	.....	.....	.....	.....	.....	.....
				SW	11	W	Strong	W	Strong.	W	Strong.
26	10.00-5.00	27	.....	W	9	.....	.....	.....	.....	.....	.....
					8	W	Strong	W	Strong.	.....	.....
27	8.00-3.30	25	.....	SW	7	W	do	W	Moderate.	.....	.....
					8	.....	.....	.....	.....	.....	.....
28	10.00-2.30	21	.....	SW	6	.....	.....	.....	.....	W	Strong.
					7	W	Strong	W	Strong.	SW	do.
May 1	8.00-10.00	27	.....	W	8	W	Slight	W	Slight.	.....	.....
2	2.00-3.00	24	.....	SW	12	.....	.....	.....	.....	.....	.....
					1	NW	Strong	W	Strong.	W	Strong.
3	9.00-3.00	26	.....	SW	9	.....	.....	.....	.....	.....	.....
					10	W	Strong	W	Strong.	W	Strong.
4	8.00-1.00	28	.....	SW	9	.....	.....	.....	.....	.....	.....
					11	W	Strong	SW	Strong.	S. of W.	Strong.
5	10.00-5.00	29	.....	SW	7	.....	.....	.....	.....	.....	.....
					11	W	Strong	W	Strong.	.....	.....
6	8.00-2.00	41	.....	S	4	.....	.....	.....	.....	.....	.....
					8	W	Strong	SW. to NW.	.....	.....	.....
7	10.00-5.00	40	.....	SW	7	.....	.....	.....	.....	.....	.....
					8	W	Moderate	W	Moderate.		
8	8.00-5.00	36	.....	SW	4	.....	.....	WSW	.....	.....	.....
					5	W	Slight	NW.			
9	5.00-9.00	25	.....	SW	4	.....	.....	.....	.....	.....	.....
					5	W	Strong	W	Strong.	W	Strong.
10	7.00-10.30	38	.....	SW	3	.....	.....	.....	.....	.....	.....
					4	W	Slight	W	Slight.	W	Strong.
	11.30-12.30	38	.....	SW	.....	W	do	SW	do.	SW	Slight.
11	12.30-3.00	45	.....	SW	4	.....	.....	W	.....	.....	.....
					5	W	Slight	NW	Slight.	SW	Slight.
12	10.00-2.00	36	.....	SW	5	.....	.....	W	do.	W	do.
					4	W	Slight.				

in different parts of "smoke zone"—Continued.

General notes regarding smoke.	Data regarding SO_2.									
	Station 2.			Station 1.			Automobile laboratory station.			
	Number of tests.	Parts of SO_2 per one million parts of air.		Number of tests.	Parts of SO_2 per one million parts of air.		Place.	Number of tests.	Parts of SO_2 per one million parts of air.	
		Average.	Maximum.		Average.	Maximum.			Average.	Maximum.
Smoke along channel; path AOC.	.....	.....	.....	9	.20	.40	Carty's place.....	9	<.20	.20
Path AOC.....	9	.20	.20	12	.20	.40	.....	.....	.....	.....
Path AOC	12	<.20	<.20	16	.50	.80	.....	.....	.....	.....
Path AOC	10	<.20	<.20	12	<.20	.40	Shipyard.....	8	.30	.60
Path AOC	14	<.20	<.20	13	.25	.60	.....	.....	.....	.....
Path AOC	5	<.20	<.20	6	<.20	.20	.....	.....	.....	.....
Path AOC	13	<.20	<.20	15	.20	.40	.....	.....	.....	.....
Path AOC	13	<.20	<.20	16	.40	.80	.....	.....	.....	.....
.....do.....	8	<.20	<.20	8	.35	.80	.....	.....	.....	.....
Path AOC	8	<.20	<.20	9	.30	.80	Anderson Hotel...	6	<.20	.20
Path AOC	4	.20	<.20	5	.30	.40	.....	.....	.....	.....
Path AOC	20	<.20	<.20	22	.35	1.00	.....	.....	.....	.....
Path AOC	19	<.20	<.20	22	.30	.60	.....	.....	.....	.....
Path AOC	20	<.20	<.20	18	.40	.60	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	Shipyard and Carty's.	17	.25	.60
Path AOC	20	<.20	.80	19	.30	.60	Anderson Hotel...	6	.20	.20
							Midway saloon....	5	.20	.40
Path AOC	18	.20	.60	19	.45	.60	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Path AOC	20	<.20	.20	23	.50	.80	.....	.....	.....	.....
.....do.....	10	<.20	.60	12	.50	.80	Shipyard.....	10	.40	.80
							Arsenal.....	7	<.20	.20
Path AOC	4	.25	.40	6	.35	.60	.....	.....	.....	.....
Path AOC	4	<.20	<.20	3	.30	.40	Anderson Hotel...	6	.20	.40
.....	12	<.20	.20	18	.60	1.00	At shipyard and Carty's place.	20	.20	.60
Path AOC.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Path AOC	7	<.20	<.20	12	<.20	.20	At shipyard and Carty's place.	17	<.20	.40
Path AOC	16	<.20	<.20	18	.50	.80	.....	.....	.....	.....
Along path AOC.....	13	<.20	.60	15	.50	.80	.....	.....	.....	.....
Along path AOC.....	11	<.20	<.20	22	.50	.70	.....	.....	.....	.....
Along path COD	19	.30	1.00	23	.30	.55	.....	.....	.....	.....
In path COD.....	8	.20	.80	9	.35	.60	Shipyard.....	7	.45	.75
In path COD.....	5	.45	1.00	12	.40	.60	Carty's place.....	12	.35	.75
.....do.....	4	.90	1.00	4	.30	.40	Glen Cove.....	4	1.30	2.25
.....do.....	1	1.00	3.00	8	.30	.60	City wharf.....	4	<.20	.40
Path COD	6	1.50	3.20	.....	.....	.....	Carty's place.....	7	.90	1.25

In order to make clearer the data obtained simultaneously on the days when the smoke conditions were the worst, they have been separated from the total and given below:

Data obtained simultaneously on days when smoke conditions were worst.[a]

OCTOBER 8, 1913.

Time 11.45 a. m. to 1.30 p. m.
Moderate west or southwest wind.
Rate of sulphur elimination from smelter, 11 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	0.90	1.15
At Corcoran's place almost in direct line behind station 2	.35	.50

OCTOBER 10, 1913.

Time 11.30 a. m. to 4.30 p. m.
Very slight west wind; smoke drifting in path AOC.
Rate of sulphur elimination from smelter, 21 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	0.40	0.80
Station 1	1.00	2.40
At shipyard northwest of station 1	<.20	<.20

NOTE.—The puff of smoke that drifted past station 1 did not extend as far north as the shipyard.

OCTOBER 20, 1913.

Time 2.30 p. m. to 5 p. m.
Very slight west wind; velocity, 2 miles per hour.
Rate of sulphur elimination from smelter, 8 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	1.10	2.20
Station 1	.60	1.60
Benicia city wharf	<.20	.60

OCTOBER 21, 1913.

Time 11 a. m. to 4 p. m.
West wind; velocity, 3 miles per hour.
Rate of sulphur elimination from smelter, 16 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	1.10	4.30
Station 1	<.20	.30
Near cemetery north of Benicia	<.20	.20

OCTOBER 27, 1913.

Time 1 p. m. to 4 p. m.
West wind; velocity, less than 2 miles per hour.
Rate of sulphur elimination from smelter, 40 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	1.10	1.60
Station 1	.80	1.90
At house on Dana place	.70	1.10

[a] See Plates VI and VII.

OCTOBER 28, 1913.

Time 11 a. m. to 3 p. m.
West wind; velocity, less than 2 miles per hour.
Smoke in the path COD.
Rate of sulphur elimination from smelter, 40 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	1.40	7.10
Station 1	.50	1.50
Near cemetery east of Selby's house	<.20	.20

MAY 10, 1914.

Time 7 a. m. to 10.30 a. m.
West and southwest wind; velocity, 3 miles per hour.
Smoke in the path COD.
Rate of sulphur elimination from smelter, 38 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	0.45	1.00
Station 1	.40	.60
Shipyard	.35	.75

MAY 11, 1914.

Time 12.30 p. m. to 3 p. m.
West and southwest wind; velocity, 4 miles per hour.
Smoke along the paths COD and AOC.
Rate of sulphur elimination from smelter, 45 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	1.00	3.00
Station 1	.30	.60
City wharf	<.20	.40

MAY 12, 1914.

Time 10 a. m. to 2 p. m.
West or southwest wind; velocity, 4 miles per hour.
Smoke in path COD.
Rate of sulphur elimination, 36 tons per 24 hours.

LOCATION.	Parts of SO_2 per million parts of air. Average.	Maximum.
Station 2	1.50	3.20
Carty's place	.90	1.25

DETERMINATIONS MADE AT TIMES WHEN THE SELBY SMOKE WAS SMELLED, OR WAS SUPPOSED TO HAVE BEEN SMELLED.

The results of determinations of SO_2 at times when the smoke from the Selby smelter was smelled, or was supposed to have been smelled, are given below.

Determinations Made When the Smoke Was Smelled by Chemists of the Commission.

IN AGRICULTURAL AREA.

September 26, 1913.

The smoke was smelled faintly for about 15 seconds by Mr. A. E. Wells and Mr. G. N. Libby. The samples taken at that time at station 2 contained 3.0 parts of SO_2 per million parts of air.

October 21, 1913.

At. 1.50 p. m., Mr. H. L. Long detected the odor of sulphur dioxide. The sample taken at that time contained 4.3 parts of SO_2 per million parts of air.

At 1.55 p. m., the smoke had drifted away from the station, and a sample taken then analyzed 0.4 parts of SO_2 per million parts of air. No smell noted.

At. 2.25 p. m., the smoke drifted past the station, and the concentration of the sulphur dioxide at that time was found to be 2.35 parts per million. Smell noted.

At 2.40 p. m., the smoke had drifted back to the Straits and the air then contained but 1.3 parts of SO_2 per million parts of air. No smell at station 2 noted.

October 28, 1913.

From 11 a. m. to 1 p. m., the smoke was dense around station 2, and was smelled almost continuously between 11 a. m. and 11.30 a. m. The two samples taken during that time analyzed 7.1 parts and 4.9 parts of SO_2 per million parts of air. Again at 12.30 p. m., for about 10 minutes the smoke became strong enough for its detection by smell, and the analysis of the sample gave 5.5 parts of SO_2 per million parts of air.

Note.—Sulphur dioxide was not smelled at station 2 again until May 12, 1914.

May 10, 1914.

At the resort at Glen Cove, Mr. H. L. Long detected the smell of sulphur dioxide as several rather dense puffs of smoke drifted past. However, an analysis of the sample taken during the time one puff was passing gave only 2.3 parts of SO_2 per million parts of air.

May 12, 1914.

At. 12.20 p. m., the smoke was dense around the station; the concentration of the sulphur dioxide in the air was found to be 3.2 parts per million parts of air.

IN BENICIA CITY.

October 10, 1913.

In the morning Mr. J. D. Enas smelled sulphur dioxide slightly at station 1, but was not prepared to take any samples during the few minutes that the smell lasted. At the same time, Mr. G. N. Libby was making determinations at the shipyard, about three-fourths of a mile west and slightly north of station 1, but did not smell the smoke nor detect sulphur dioxide in any sample taken during the morning. At no other time was sulphur dioxide smelled at station 1.

On two other occasions Mr. Enas detected an odor that he believed was from the smelter, but could not identify it as sulphur dioxide or trioxide.

November 20, 1913.

From 4.30 to 5 p. m., Mr. Enas and Mr. Libby just detected this "smelter odor." They were satisfied that the odor was not due to the oil refinery, but at the same time both failed to find any sulphur dioxide in the samples taken then.

October 27, 1913.

The afternoon when the smoke and wind conditions were the worst possible for Benicia, Mr. Libby was taking samples at the Dana place, about 1 mile north of the Vallejo-Benicia Road.

From 4.05 to 4.15 p. m., Mr. Libby detected the odor of sulphur dioxide in passing puffs of smoke. However, the samples taken at that time failed to show the presence of more than 1 part of SO_2 per million parts of air.

The samples taken earlier in the afternoon, when the smoke was not observed or suspected in the vicinity, contained more sulphur dioxide than 1 part per million parts of air. The explanation of this anomaly must be that the puffs of smoke carrying a concentration of sulphur dioxide high enough to be detected by smell were only momentary and had passed before the sample could be taken. Mr. Libby is very sensitive to the smell of sulphur dioxide.

The above-mentioned records are the only recorded times when the smoke could be smelled in Benicia or the surrounding country by the field men of the commission. The writer personally smelled the smoke at station 1 on September 26 and October 21 and 28, 1913, but never detected the odor or taste of sulphur dioxide at any other point or at any other time in the "smoke zone."

Between September 17 and 30, and on several occasions in October, the writer stayed over night in the "smoke zone" for the express purpose of determining whether the wind conditions were such during the night that higher concentrations of sulphur dioxide would be found than during the day. During several evenings and early mornings in that time the atmosphere was calm or a slight west wind prevailed, but the writer detected no odor of sulphur dioxide. The writer spent many late evening hours and early morning hours on the wharf extending out into the straits from Glen Cove, when the wind was seemingly causing the smoke to drift directly from Selby to the point, yet no odor of sulphur dioxide was detected. The conclusion reached was that during the night or early morning hours no abnormal condition existed that would tend to increase the sulphur dioxide content of the air beyond the concentration that would be found under the same wind conditions in the day time. Thus, the sulphur dioxide content found in the atmosphere on October 27 and 28 and on other days when the smoke was gently drifting over the area must be the maximum possible.

DETERMINATIONS MADE AT TIMES WHEN RESIDENTS STATED THAT "SMELTER SMOKE" WAS SMELLED BY THEM.

The results of determinations made at times when residents in the "smoke zone" stated to chemists of the commission that "smelter smoke" was smelled by them are presented below.

SEPTEMBER 17, 1913.

Witness No. 78 claimed to smell the "smelter" at the place where Mr. Libby and Mr. Wells were taking samples. They failed to smell it, however. The maximum analyses of the samples taken at that time was 0.8 part of SO_2 per million parts of air.

SEPTEMBER 25, 1913.

In the middle of the afternoon witness No. 24 stated that he detected the smoke near the shipyard.

From 12.30 to 5.45 p. m. samples were taken at the end of G Street, Benicia.

From 12.30 to 1.30 p. m. the average concentration of sulphur dioxide in the samples was 1.30 parts of SO_2 per million parts of air.

After 1.30 p. m. the breeze from the west freshened and the concentration averaged about 0.6 part of SO_2 per million parts of air, with a maximum concentration of 1 part per million.

SEPTEMBER 30, 1913.

At 11 a. m. witness No. 28 informed Mr. Dutton and Mr. Wells that he smelled the "smelter" distinctly. They were standing at his house at the time. The wind was from the north or northeast and had been from that quarter all the morning, so that no Selby smoke could be in the vicinity. Neither Mr. Dutton nor Mr. Wells could detect any foreign odor whatsoever. At that time Mr. Libby was at the Rose place, and his records state that the wind was from the north or northeast, and show no sulphur dioxide in the atmosphere.

OCTOBER 6, 1913.

Mr. Libby was at Robertson shipyard.

At 3.15 p. m. witness No. 75 stated that he smelled "smelter smoke" distinctly.

The wind was slightly south of west, and although at 2 to 2.30 p. m. Mr. Libby detected slight oil odors, he found no sulphur dioxide in the samples taken between noon and 5 p. m.

OCTOBER 9, 1913.

From 6.40 a. m. to 2.40 p. m. Mr. Libby was taking samples at the Anderson Hotel.

At 7.30 a. m. an elderly gentleman at the hotel stated that the smoke made his eyes smart and water. At that time Mr. Libby detected a very slight oil odor, but samples taken then contained no determinable amount of sulphur dioxide.

OCTOBER 14, 1913.

Mr. Libby was taking samples on the north side of the Vallejo-Benicia Road, about one-half mile west of Burke's saloon.

At 3 p. m. Mr. Libby smelled a slight oil odor and the samples taken then contained about 0.6 part of SO_2 per million parts of air.

A lady residing in the house near this point of sampling stated that she could smell the smelter smoke distinctly.

OCTOBER 15, 1913.

At 9.40 a. m. a lady near the high school in Benicia stated to Mr. Libby that she could "smell the smelter." Mr. Libby could detect a slight odor of oil. A sample taken then contained 0.4 part of SO_2 per million parts of air.

OCTOBER 16, 1913.

At 8 a. m. witness No. 48A stated to Mr. Libby that she could "smell smelter." Mr. Libby could not smell any sulphur dioxide. Samples taken then at her house analyzed 0.4 part of SO_2 per million parts of air.

OCTOBER 22, 1913.

At 8 a. m. witness No. 20A said that he could "smell smelter smoke." Mr. Libby was in a vacant field near the house of witness No. 20 at that time, and could detect no odor. Analyses of samples taken at that time showed the presence of only 0.6 part of SO_2 per million parts of air.

At the times when the smoke was observed by smell by the chemist at station 2 during September, October, and November, the smoke was also observed by the employees of the Pacific Gas & Electric Co. at their transformer station near station 2. No records of their having smelled it at other times were made.

At the Glen Cove resort complaint of "smelter-smoke smell" was made several times. On several occasions after dark the smell of sulphur dioxide was also noted momentarily by witness No 148, who lived there during October and November. The writer was in Glen Cove several nights during September and on many days during October and November when the wind was blowing the smoke directly to Glen Cove or along the above-mentioned path COD, and did not detect the smell of sulphur dioxide.

As stated above, on several evenings in September, the writer stayed for hours out on the wharf projecting into the straits from Glen Cove, when the wind was apparently blowing the smoke directly from Selby, and got no odor of sulphur dioxide.

In May, 1914, Mr. H. H. Bartells detected the smell in Glen Cove on one occasion.

In order to facilitate the work of the commission in the effort to determine the concentration of the sulphur dioxide in the atmosphere at times when the smelter smoke was noticed by people residing in the smoke zone, a number of cards were printed with the form shown below:

Date.....

GENTLEMEN: The smoke from the Selby smelter was noted by myself

or by.....

Date.....

Time.....

Duration of smell.....

Degree of strength of smell—strong...., moderate...., or slight....

Place a cross to indicate the degree of strength.

Signed.....

Between October 4 and 8, 1913, 150 of these cards were given out to about 35 people in the district. Of the 150 cards, only 16 replies were received. Only 8 of the 35 persons to whom cards were given replied at all, and these were all in four families.

One card was received from witness No. 66, complaining of the smoke between 10 a. m. and 12 m. on October 10. This was the time that Mr. Enas thought he smelled sulphur dioxide at the place of

witness No. 78, about 1 mile from the house of witness No. 66. During that time Mr. Libby was at the shipyard, about halfway between the two points, and neither smelled sulphur dioxide nor detected its presence by analytical methods.

Five cards were received stating that the "smoke was strong" at 5 p. m. on that same date, October 10, from two families residing near each other in the residential portion of Benicia. No analyses were made at 5 p. m., as the last had been made by Mr. Libby at the shipyard at 4.30 p. m. At that time his record states the west wind was very slight or calm, but no determinable amount of sulphur dioxide was present in the samples taken.

Witness No. 51A reported "strong smell of smelter smoke" between 9 and 10 a. m. on the 11th of October, at which time there was an east or northeast wind blowing. In this instance the wind was blowing toward the smelter.

On October 16 witness No. 66 reported "strong smell of smoke between 6 and 8 a. m.," the same hour that witness No. 48A reported smelling it to Mr. Libby. As stated previously, Mr. Libby did not then smell it, and samples taken at that time contained only 0.4 part of SO_2 per million parts of air.

Witness No. 20 reported "smell of smoke" at 5 a. m. on the 17th of October. No analyses were made at that time. At 6.45 a. m. Mr. Libby was at the house of witness No. 118, about one-half mile south of the place of witness No. 20 and found less than 0.4 part of SO_2 per million parts of air

Between 3 and 4 p. m. on that same date, the 17th of October, witness No. 66 again reported "smelter smoke." During that time the smoke was observed traveling along the path COD toward station 2, but was not detected by smell there. The maximum concentration found at station 2 during that time was 1.20 parts of SO_2 per million parts of air. Mr. Enas at station 1 reported no smoke around Benicia between 3 and 4 p. m.

On October 18, between 3 and 5 p. m., witness No. 66 again reported "smelter-smoke smell." Up to 3 p. m. of that day the wind had been from the east. At 3 p. m. the east wind died down and the air became calm. No samples were taken after 3 p. m., but both Mr. Long, at Glen Cove, and Mr. Enas, at Benicia, stated that the Selby smoke did not go east along the straits at all during the afternoon.

On October 21 witness No. 20B reported "smelter smoke" between 8 a. m. and 12 m. Mr. Libby made analyses near the cemetery on top of the hill near the place of witness No. 20 from 7.30 a. m. until 2.45 p. m. of that day. His records state that a moderate west wind was blowing and that it was very hazy and foggy during the whole morning. He did not smell sulphur dioxide, and only 4 of the 22 samples taken at that time contained a determinable amount of sulphur dioxide, the maximum being 0.6 part of SO_2 per million parts of air. Mr. Enas

and Mr. Long reported the smoke lying along the Contra Costa shore all the morning.

On October 22 witness No. 20C noted the "smoke" during the morning. Mr. Libby, in a field within 200 yards of the house, found less than 0.4 part of SO_2 per million parts of air. Mr. Enas, at station 1, found a maximum of 0.4 part of SO_2 per million parts of air during that time.

No cards were received after October 22. It should be noted that all cards received stated that the smoke was strong.

It is important to note that on October 27 and 28, when the smelter was discharging a maximum quantity of sulphur dioxide, under directions from the commission, and the wind conditions were the most unfavorable, thereby drifting the smoke directly to Benicia, no complaints by cards were received. The only complaints made were by witness No. 149 and witness No. 132 to the writer. Witness No. 149 resides at the turn of the Vallejo-Benicia road, just west of the shipyard. During the morning of the 27th the smoke had hugged the Contra Costa shore very closely, and had not been noted by our field men on the Solano shore. At noon the smoke started drifting across the straits, and during the greater part of the afternoon was visible around Benicia.

At 3 p. m. witness No. 149 stated that the smoke had been very disagreeable all the morning between 9 and 11 a. m. and had given her a headache. (During this period of time station 1 took nine samples, which averaged 0.3 part of SO_2 per million parts of air. Station 2 took seven samples, which averaged 0.4 part of SO_2 per million parts of air.) At 3 p. m. she could not detect the smoke, though the writer suggested that it might be possible for her to do so.

During the early afternoon of October 27 witness No. 132, who was around the Benicia garage, complained to the writer of the smoke. This was the time when the dense smoke was drifting over Benicia under a very slight westerly breeze, and a concentration of 1.9 parts of SO_2 was determined at station 1.

Of the 30 families or houses supplied with the record cards replies were received from only 4. As all to whom these cards were given expressed a willingness to help us in the investigation to the extent of filling out the cards whenever the smoke was noted, it is reasonable to believe from the fact that no other people sent in cards that none of the others smelled the smoke at any time during the investigation.

Two of the people who did reply noted the smelter smoke on two different occasions when, due to the wind conditions, the smoke could not possibly be in the vicinity of Benicia.

Other reports were received stating that the smoke was noted at times when our field men could not observe it and could find not more than one-half part sulphur dioxide per million parts of air by

analysis of samples taken then. Mr. Libby is especially sensitive to the smell of SO_2; and if he could not detect the presence of SO_2 in Benicia it is rather difficult to believe that others could.

Thus the value of the data from the cards as a record of the times the smoke was present in Benicia is rather doubtful.

Because of the unsatisfactory data obtained with these cards in the effort to determine the sulphur-dioxide concentration when the smell was noted it was decided to carry out some tests to determine the sensitiveness of various persons to the gas. These tests are described in another section of the report.

DETERMINATIONS MADE ON "INSTANTANEOUS SAMPLES" WHEN THE FUMES FROM THE OIL REFINERY WERE NOTED BY THE FIELD MEN OF THE COMMISSION.

At certain stages in the refining of crude oil for asphalt manufacture there are evolved fumes and gases of hydrocarbon compounds probably containing sulphur. These fumes have an extremely disagreeable odor. It has been claimed that prior to 1911 these fumes were allowed to escape from the refinery of the Union Oil Co. at Oleum into the atmosphere and were present in the Selby smoke zone. In 1911 the stills in which the asphaltum is produced were capped, and most of the fumes are now prevented from going out into the air.

It is evident that the oil fumes are not so prevalent in the Selby "smoke zone" now as in former years. However, these fumes still continue to drift at times over Benicia and the rest of the "smoke zone." The writer noted these fumes on many occasions, and on several days they were sufficiently strong to be disagreeable. At White's ranch, on September 26 and on October 25, 1913, the oil fumes were so strong as to be almost nauseating.

An interesting feature in regard to the oil fumes is that they come along over the areas suddenly and frequently are present for a considerable length of time, sometimes for two or three hours.

These frequent and long-time fumigations with the oil fumes, even at the present time when the Union Oil Co. at Oleum has by capping their stills apparently eliminated the emission of these fumes into the air, would indicate that before the stills were capped the oil fumes must have been present very often and in considerable strength.

The odor of the fumes from the oil refineries at Oleum have been confused most certainly with the odor of the sulphur-dioxide gas from the Selby smelter by many of the residents of the area. On several occasions complaints against the smelter fumes were made to the field men when they could not detect any sulphur dioxide by smell, but could detect the odor of the oil fumes. On a few occasions samples of the air were taken and found to contain much less than 1 part SO_2 per million parts of air.

The following table shows the data obtained at times when the smell of oil-refinery fumes was noted by the field men of the commission. These figures do not represent the total number of times the odor was noted, being only a record of the times when the oil odor was noted and samples of the air were taken simultaneously. It will be seen that the sulphur-dioxide content of the air samples taken at times when the oil was smelled does not bear a definite relation to the degree of strength of the oil odor. There was not always a determinable sulphur-dioxide contamination simultaneous with the "oil odor." Conversely, the "oil smell" was not always noted when the determinable amounts of sulphur dioxide were found. Frequently, however, both oil fumes and sulphur dioxide were present at the same time.

Summary of data concerning the "smell of oil."

Date.	Time of day.	Place.[a]	Wind.	Observer.	Degree of smell.	Amount of SO_2 at time of observation.
						Parts per million.
1913.						
Sept. 18	2.20- 2.30	Station 2	Slight W	Wells and Libby.	Slight	0.50
18	3.00- 3.10	do	do	do	do	.35
20	10.50-11.05	do	Strong W	Wells	do	.35
24	10.55-11.05	Station 1	Moderate W	do	do	.30
26	8.00- 9.00	Station 2	Slight W	Wells and Libby.	Strong	1.00
26	2.30- 3.00	do	do	do	do	1.75
30	3.00- 4.00	Rose	Slight SW	Libby	do	2.40
30	4.00- 5.30	do	do	do	Slight	1.95
Oct. 4	11.35-12.00	Carty	West	do	do	.50
8	11.00-12.00	Corcoran	Southwest	do	do	.80
9	6.40- 8.00	Anderson	Slight W	do	do	< .20
14	2.30- 2.45	Passalacqua	do	do	do	.60
14	4.30- 5.00	Station 1	do	Enas	Strong	< .20
15	9.40-10.00	Schoolhouse	do	Libby	Slight	< .20
15	11.30-12.00	do	do	do	Strong	.50
25	10.30- 1.00	Station 2	do	Long and Wells.	Very strong	.40
25	11.15- 1.40	Carty	do	Libby	do	.55
27	3.00- 5.00	Station 1	do	Enas	Strong	.50
28	11.45- 1.00	Catholic cemetery.	do	Libby	do	< .20
29	9.00-10.00	Station 1	do	Enas	Moderate	< .20
Nov. 9	1.00- 1.30	Carty	do	Libby	Slight	< .20
1914.						
Mar. 20	8.00- 9.00	Station 1	Moderate W	Enas	Distinct	.30
22	12.00- 3.00	do	do	do	do	< .20
25	2.00- 3.00	do	Slight W	do	do	.60
27	1.00- 2.00	do	Moderate W	do	do	.30
27	3.00- 4.00	do	do	do	do	.30
Apr. 2	8.15- 8.30	do	do	do	do	< .20
2	3.00- 4.00	do	do	do	do	.50
3	10.00-11.00	do	Strong W	do	do	.20
5	9.30- (b)	do	do	do	do	.00
5	12.00- (b)	do	do	do	do	.00
7	9.00-12.00	do	Slight W	do	do	.55
9	4.00-	do	West	Bartells	do	.00
11	11.00-12.00	Station 2	SW and N	do	do	.00
11	9.30-10.30	Station 1	do	Enas	do	.00
14	8.00- 9.00	do	Slight W	do	Strong	.60
28	11.00-12.00	Station 2	West	Bartells	do	.00
May 4	1.00- 3.00	Station 1	Southwest	Noreen	Distinct	.00
8	12.00- (b)	Station 2	West	Bartells	do	.00

[a] See Plates VI and VII.

[b] End of period not definitely known.

DETERMINATIONS OF SO_2 MADE ON "INSTANTANEOUS" SAMPLES TAKEN IN THE SELBY SMOKE STREAM IN CONTRA COSTA COUNTY.

DETERMINATIONS MADE IN CROCKETT.

During October and November, 1913, the Selby smoke was observed many times drifting or lying closely over Crockett. Thus it was thought desirable to determine the sulphur dioxide content of the atmosphere at that place when the Selby smoke was present, especially as the residents of Crockett were not complaining of the smoke. For this purpose a set of apparatus was moved to Crockett in December and placed in a house on the top of the hill near the schoolhouse. Unfortunately, during December the wind was generally from the southeast or east and the Selby smoke was blown toward Crockett only for short periods at long intervals. Thus the greater number of the samples taken (82 out of 87) contained less than 0.2 part sulphur dioxide per million parts of air. After carrying on the tests here for about two weeks the apparatus was dismantled and moved back to station 2 at the White ranch.

Results of determinations made in Crockett.

Date.	Wind.	Number of tests.	Parts of SO_2 per million parts of air.	
			Average.	Maximum.
1913.				
Dec. 3	Southeast	8	<0.20	<0.20
4	Southeast and west	13	< .20	.20
5	do	14	< .20	.40
6	Southeast	9	< .20	< .20
8	do	7	< .20	< .20
9	do	9	< .20	< .20
10	do	8	< .20	< .20
11	do	12	< .20	< .20
12	do	7	< .20	< .20

DETERMINATIONS MADE NEAR SELBY SMELTER AND TORMEY.

On the morning of December 1, 1913, a very strong wind, slightly west of north, was blowing the Selby smoke directly against the hills southeast of the smelter and at times around the "mess house." An attempt was made to determine the sulphur dioxide in the smoke stream at a short distance, about one-quarter mile, from the smelter. The necessary apparatus was carried up on the hill and set up at a point where the smoke stream apparently was striking most often. As shown by the following tabulated results of determinations, the sulphur dioxide content of the air was extremely variable. At times, the sulphur dioxide was smelled strongly for several seconds, and then not again for many minutes. We used the water method of sampling which required about 15 seconds. During the taking of only one sample was the smoke continuously present around the aspirator.

During the morning there were in operation two Dwight & Lloyd machines and one Ropp roaster. Occasionally the acid particles in the smoke stream were felt striking against the face.

Results of determinations made on Dec. 1, 1913, on hill southeast of Selby roaster stack.

[Wind, brisk, west of north.]

Time.	Parts of SO_2 per million parts of air.	Notes.
a. m.		
10.15	2.3	Smoke blown overhead.
10.25	4.5	Smoke around aspirator during part of sampling detected by smell.
10.32	2.0	Smoke high overhead.
10.45	6.8	Smoke around aspirator whole time.
10.49	1.8	Smoke overhead not smelled.
10.55	8.2	Smoke around aspirator about 10 seconds.
11.05	1.0	Smoke high overhead.
11.15	.5	Smoke blown 100 yards to south.
11.20	1.2	Smoke overhead.
11.24	4.5	Smoke blown past aspirator in puffs.
11.32	2.0	Smoke overhead.
11.37	1.0	Smoke blown 100 yards to south.

On December 2, 1913, Mr. Libby obtained the following tabulated results in Tormey and south of Tormey. The wind conditions were about the same as on the preceding day.

Results of SO_2 determinations in Tormey and south of Tormey on Dec. 2, 1913.

Time.	Parts of SO_2 per million parts of air.	Remarks.
a. m.		
10.30	0.0	Samples taken in Tormey directly under smoke stream and three-quarters of a mile south of smelter.
10.37	.3	
10.45	.0	
11.00	.3	
11.10	1.2	
11.20	2.1	
11.40	.9	Samples taken one-quarter mile south of Tormey in smoke stream; occasional odor of sulphur dioxide noticeable.
12.00	.9	
p. m.		
12.10	1.2	
12.20	.4	
1.30	.0	Samples taken on railroad track one-quarter mile south of Tormey.
1.40	.0	
1.50	.0	
2.05	1.5	Samples taken on railroad track close to Tormey, three-quarters of a mile south of smelter stack; occasional odor of sulphur dioxide noticeable.
2.15	2.8	
2.30	.0	
2.35	.3	Samples taken at point one-half mile south of Tormey; smoke headed directly to point; occasional odor of sulphur dioxide noticeable.
2.40	.3	
2.45	.9	
2.55	.6	
3.05	1.8	
3.15	3.6	
3.25	.6	
3.35	.6	

These results show the extent to which the sulphur dioxide content of the air may vary directly in the path of the smoke stream in a brief period of time, owing to the slight changes in the wind direction and velocity.

TOTAL-SULPHUR DETERMINATIONS IN SELBY "SMOKE ZONE."

As a check on the sulphur dioxide determinations from "instantaneous" samples, and also to determine the presence of appreciable amounts of other sulphur compounds, it was decided to determine the total-sulphur content of the atmosphere in the Selby smoke zone. As stated in the description of the method in another part of this report (p. 189), this determination required the aspiration of a relatively large volume of air and occupied considerable time.

In general, each determination extended over a period of about eight hours, although there were several instances where the air was aspirated through the same solution on several successive days.

The total number of these determinations made was 177.

GENERAL SUMMARY OF DATA OBTAINED.

A summary of the data obtained is given in the following tables:

General summary of data obtained in total-sulphur determinations in Selby smoke zone.

Place of sampling.	Number of determinations.	Total sulphur calculated to parts of SO_2 per million parts of air.	
		Average.	Maximum.
Station 1	63	0.21	0.69
Station 2	73	.29	1.50
Auto in Benicia	31	.28	.80
Auto in farming area	10	.22	.40
	177	.26	.....

Comparison of results from total-sulphur determinations with results of determinations from "instantaneous" samples.

Place of sampling.	Parts of SO_2 per million parts of air.	
	Average calculated from total sulphur determinations.	Average of instantaneous samples.
Station 1	0.21	0.20
Station 2	.29	.24
Auto in Benicia	.28	< .20
Auto in farming area	.22	.22

DETERMINATIONS AT STATION 1.

A summary of the total-sulphur determinations made at station 1 is presented below.

Summary of total-sulphur determinations at station 1.

Month.	Number of determinations.	Hours included.	Total sulphur calculated to parts of SO_2 per million parts of air.		
			Average.	Maximum.	Proportional to hours.
September	.....	.....	.....	.....	.....
October	17	133½	0.20	0.44	0.19
November [a]	17	157	.26	.69	.26
March	9	64½	.21	.40	.23
April	13	211	.18	.30	.....
May	7	116	.23	.62	.....
	63	682	.21	.....	.22

[a] Results include results of tests on two days in December.

Parts of SO_2 per million parts of air, average of tests, 0.21.
Parts of SO_2 per million parts of air, average proportional to time, 0.22.
Total number of cubic feet sampled, 1,429.
Average number of cubic feet per sample, 22.8.
Maximum number of cubic feet per sample, 90.8.
Minimum number of cubic feet per sample, 10.3.
Average rate of aspiration, liters per minute, 1.2.

For the purpose of comparison, the total-sulphur determinations made at station 1 have been classified under two heads: (1) Determinations made when the general wind direction was from the west; (2) determinations made when the wind was from a quarter other than the west.

Summary of determinations made under two classes.

Class.	Number of tests.	Total sulphur calculated to parts of SO_2 per million parts of air.	
		Average.	Maximum.
1	36	0.25	0.69
2	27	.16	.44
	63	.....	.....

Comparison of results from total-sulphur determinations with results of determinations from "instantaneous" samples.

Class.	Parts of SO_2 per million parts of air.	
	Total sulphur determinations.	Average of instantaneous samples.
1	0.25	0.23
2	.16	>.20

Results of total-sulphur determinations made at station 1.

OCTOBER, 1913.

Day of month.	Time.	Hours.	Volume of sample.	Total sulphur calculated to parts of SO_2 per million parts of air.	General wind conditions.
			Cu. ft.		
13	7.30–3.30	8	20.2	0.23	West and southwest, brisk.
14	7.00–3.45	8¾	20.0	.07	South and southwest, light.
15	7.45–4.50	9	18.2	.22	Northwest.
16	7.20–3.25	8	18.1	.11	West; slight breeze.
17	7.15–4.00	8¾	20.0	.10	Do.
18	7.35–2.45	7¼	15.8	.44	Northeast wind.
20	7.30–4.00	8½	18.0	.22	Northeast, a. m.; west, p. m.
21	8.10–3.55	8	14.2	.10	West wind.
22	7.25–4.00	8½	20.2	.07	West wind; brisk.
24	7.15–3.40	8½	22.5	.27	Northwest wind; brisk.
25	10.15–4.50	6½	16.2	.20	Slight west wind.
26	9.40–4.30	7	18.0	.08	East and south wind; brisk.
27	7.20–4.20	9	18.3	.35	Slight west breeze.
28	9.05–2.10	5	8.0	.38	Do.
29	8.50–4.50	8	16.7	.39	Strong west breeze.
30	7.55–3.10	8¼	16.4	.12	Northwest and west breeze.
31	8.00–2.35	6½	14.3	.00	Calm or slight west.

NOVEMBER, 1913.

2	8.45– 2.45	6	12.2	0.38	Slight west or northwest wind.
3	8.00– 2.45	6¾	14.3	.35	Slight west or north wind.
4	8.30– 3.45	7¼	16.4	.24	South or southeast.
6	7.45– 5.15	9½	20.3	.24	Slight southeast and variable.
7	7.45– 2.45	7	14.2	.28	Northeast and calm.
8	7.30– 3.15	7¾	18.4	.16	Northeast.
10	7.50– 4.20	8½	18.4	.45	Slight west wind.
11	10.40– 4.00	8	18.4	.14	Southeast and east.
12	1.00– 3.40				
13	8.30– 12.00	9¾	22.8	.16	North or northeast.
14	8.30– 2.45				
15	7.35– 4.05	8½	20.8	.27	West and northwest.
16	1.15– 5.00	3¾	10.5	.69	West.
19	8.05– 4.05	8	20.7	.00	Northwest.
20	8.30–12.00	3½	10.3	.29	Northwest and west.
21	8.30– 4.30	8	18.7	.24	Slight west.
22	9.30– 4.15	6¾	14.5	.28	Do.
24	7.30– 3.30	36½	95.4	.12	East or southeast three days. West or northwest two days.
25	8.25– 4.35				
26	8.00– 2.35				
28	7.25– 3.35				
29	9.25– 4.00				

DECEMBER, 1913.

1	7.40– 2.40	11	27.0	0.05	North or northeast wind.
3	7.40–11.40				

MARCH, 1914.

21	12.45–5.15	4½	10.2	0.10	West wind.
23	10.00–4.30	6½	14.5	.02	Southwest to northwest.
24	7.45–4.25	8¾	20.5	.40	South to southwest.
25	8.00–4.00	9	22.5	.16	Southwest to west.
26	8.00–5.00	9	20.5	.24	West.
27	8.05–5.05	9	20.5	.24	Do.
28	8.00–2.30	6½	16.0	.25	South.
30	9.00–1.30	4½	10.0	.30	South and southwest.
31	8.05–2.40	6½	16.0	.17	South or southeast.

Results of total-sulphur determinations made at station 1—Continued.

APRIL, 1914.

Day of month.	Time.	Hours.	Volume of sample.		Total sulphur calculated to parts of SO_3 per million parts of air.	General wind conditions.
			Cu. ft.			
1	7.45–3.35	7¾	18.0		0.17	East.
2	7.45–4.35	8¾	22.5	40.5	.28	West.
3	8.45–5.00	9	18.0			
4	8.30–3.30	7	16.0		.12	Southeast.
5	8.35–3.00	6½	12.0	28.0	.09	Southwest.
6	7.40–2.40	7	16.0			
7	7.55–2.30	6½	14.0			
8	7.40–5.05	9½	20.0			
9	7.55–5.20	9½	20.0	90.8	.14	West and southwest.
10	7.45–4.20	8½	20.0			
11	5.15–2.35	7½	16.8			
13	5.35–2.35	8	20.6	36.6	.15	West.
14	7.15–2.00	6½	16.0			
15	7.40–5.00	9	14.0	30.0	.20	Do.
16	8.25–4.35	8	16.0			
17	7.20–4.40	9½	18.0		.14	Southeast.
18	10.00–4.50	7	14.0	28.0	.30	Do.
19	10.00–4.45	7	14.0			
20	8.30–3.30	7	16.0			
21	8.00–5.00	9	18.0	50.0	.09	South or west or southwest.
22	8.55–4.45	8	16.0			
23	8.45–4.45	7	16.0	30.0	.30	West.
24	9.05–4.00	7	14.0			
27	7.00–3.45	8¾	18.0	34.0	.25	West and southwest.
28	5.45–2.30	6	16.0			
29	8.00–4.45	9	18.0	32.0	.08	Northwest.
30	7.00–1.40	6¾	14.0			

MAY, 1914.

1	8.00–4.45	8	18.0			Northwest.
2	6.00–2.45	7	16.0	48.0	0.12	West.
3	10.00–4.45	7	14.0			Southwest.
4	6.00–2.45	8¾	16.0		.06	Do.
5	10.00–4.45	7	14.0	30.0	.32	Southwest and northwest.
6	6.00–2.00	8	16.0			
7	10.00–5.45	8	16.0	34.0	.62	West.
8	8.00–4.45	9	18.0			
9	6.00–2.45	8¾	18.0	36.0	.20	Southwest, west.
10	7.15–4.00	9	18.0			
11	8.15–5.00	9	18.0	36.0	.24	Southwest to northwest.
12	5.30–2.15	9½	18.0			
13	8.00–4.45	8¾	18.0	36.0	.05	Southwest.
14	8.00–4.45	8¾	18.0			

In the following table it will be noted that some of the samples contained relatively large quantities of SO_3 compared with the average of the "instantaneous" samples. These high figures may be due to sulphates getting into the solutions in spite of all the care used in handling the samples.

Total-sulphur determinations at station 1 made when the general wind direction was from the west or slightly south or north of west.

Date.	Rate of sulphur elimination from smelter per 24 hours.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average SO_2 content of "instantaneous" samples.	Date.	Rate of sulphur elimination from smelter per 24 hours.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average SO_2 content of "instantaneous" samples.
	Tons.				*Tons.*		
Oct. 13	14	0.23	0.15	Apr. 7	27		0.50
Oct. 15	14	.22	<.20	Apr. 8	32		<.20
Oct. 16	2	.11	<.20	Apr. 9	31	0.14	<.20
Oct. 17	18	.10	<.20	Apr. 10	27		.22
Oct. 21	16	.10	<.20	Apr. 11	28		<.20
Oct. 22	12	.07	<.20	Apr. 13	27		.20
Oct. 25	9	.20	<.20	Apr. 14	20	.15	.30
Oct. 27	40	.35	.50	Apr. 15	16		.25
Oct. 28	40	.38	.40	Apr. 16	17	.20	.30
Oct. 29	38	.39	<.20	Apr. 23	33		.30
Oct. 30	16	.12	.20	Apr. 24	28	.30	.40
Oct. 31	11	0	<.20	Apr. 27	25		.50
Nov. 2	10	.38	.25	Apr. 28	21	.25	.40
Nov. 3	19	.35	.20	May 1	27		.30
Nov. 10	33	.45	.30	May 2	24	.12	.25
Nov. 15	16	.27	<.20	May 3	26		.60
Nov. 16	14	.60	.20	May 5	29		.50
Nov. 20	22	.29	<.20	May 6	41	.32	.45
Nov. 21	35	.24	<.20	May 7	40		.50
Nov. 22	36	.28	.20	May 8	36	.62	.30
Mar. 21	31	.10	<.20	May 9	25		.25
Mar. 24	18	.40	<.20	May 10	38	.20	.35
Mar. 25	21	.16	<.20	May 11	45		.20
Mar. 26	22	.24	<.20	May 12	36	.24	.20
Mar. 27	28	.24	<.20				
Apr. 2	23	.28	.25				
Apr. 3	27						

Total-sulphur determinations at station 1 made when general wind direction was from a quarter other than the west.

Date.	Rate of sulphur elimination from smelter per 24 hours.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average SO_2 content of "instantaneous" samples.	Date.	Rate of sulphur elimination from smelter per 24 hours.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average SO_2 content of "instantaneous" samples.
	Tons.				*Tons.*		
Oct. 14	16	0.07	<0.20	Mar. 23	19	0.02	<0.20
Oct. 18	17	.44	<.20	Mar. 28	24	.25	<.20
Oct. 20	8	.22	.30	Mar. 30	30	.30	<.20
Oct. 24	13	.27	.20	Mar. 31	20	.17	<.20
Oct. 26	30	.08	<.20	Apr. 1	23	.17	<.20
Nov. 4	17	.24	<.20	Apr. 4	25	.12	<.20
Nov. 6	11	.24	<.20	Apr. 5	23	.09	<.20
Nov. 7	14	.28	<.20	Apr. 6	27	.....	.....
Nov. 8	11	.16	<.20	Apr. 17	21	.14	.....
Nov. 11	12	.14	<.20	Apr. 18	24	.30	<.20
Nov. 12	14	.....	.....	Apr. 19	26	.....	<.20
Nov. 13	18	.16	<.20	Apr. 20	27	.....	<.20
Nov. 14	18			Apr. 21	22	.09	<.20
Nov. 19	16	.....	<.20	Apr. 22	21	.....	.35
Nov. 24	0			Apr. 29	23	.08	<.20
Nov. 25	0			Apr. 30	26	.....	<.20
Nov. 26	0	.12	<.20	May 4	28	.06	<.20
Nov. 28	0			May 13	22	.05	<.20
Nov. 29	39			May 14	26	.....	<.20
Dec. 1	23	.05	<.20				
Dec. 3	11						

Summary of total-sulphur determinations at station 2.

Month.	Number of determinations.	Hours included.	Total sulphur calculated to parts of SO_2 per million parts of air.		
			Average.	Maximum.	Proportional to hours.
September	5	28	1.10	1.50	1.03
October	18	147	.50	1.38	.52
November	15	161	.11	.45	.12
March	12	102	.15	.44	.13
April	16	214	.14	.26	.13
May	7	101	.25	.55	.11
	73	753	.285		

Total number of cubic feet sampled, 1,325.
Average number of cubic feet per sample, 18.2.
Maximum number of cubic feet per sample, 98.
Minimum number of cubic feet per sample, 5.8.
Average length of time per cubic foot, 34 minutes.
Average rate of aspiration of sample, liters (about) per minute, 1.2.
Parts of SO_2 per million parts of air, average proportional to time, 0.24.

The total-sulphur determinations made at station 2 have been segregated as follows:

1. Determinations made when the wind was from the west, and during part of the sampling period the smoke was headed directly to the station in the path COD (Pl. VI).

2. Determinations made when the wind was from the west, and the smoke was confined mostly to the path AOC.

3. Determinations made when the wind was from a quarter other than the west.

Summary of classified results of total-sulphur determinations at station 2.

Class.	Number of tests.	Total sulphur calculated to parts of SO_2 per million parts of air.	
		Average.	Maximum.
1	20	0.72	1.50
2	25	.09	.25
3	28	.15	.44
	73		

Comparison of results from total-sulphur determinations with results of determinations from "instantaneous" samples.

Class.	Average parts of SO_2 per million parts of air.	
	Calculated from total sulphur determinations.	Average of "instantaneous" samples.
1	0.72	0.60
2	.09	$<$ .20
3	.15	$<$ .20

Results of total-sulphur determinations made at station 2.

SEPTEMBER, 1913.

Day of month.	Time.	Hours.	Volume of sample.	Total sulphur calculated to parts of SO_2 per million parts of air.	General wind conditions.
			Cubic feet.		
18	10.15–12.30	2½	5.8	0.30	Slight east and west wind.
18	2.00– 6.50	4¾	10.5	1.30	Slight west wind.
20	7.15–12.45	5	13.0	1.20	Moderate west wind.
22	11.50– 5.45	6	15.6	1.50	Slight west wind.
26	7.45– 5.45	10	14.8	.85	Do.

OCTOBER, 1913.

9	8.10– 4.40	8½	16.1	1.03	Slight breeze from west.
10	8.10– 4.10	8	16.0	.83	
11	7.15– 2.45	7½	16.0	.29	Slight breeze from west two hours; then from north.
13	11.15– 5.45	6½	12.1	.37	Strong wind from west.
14	8.00– 4.45	8¾	19.5	.43	Moderate wind from west.
15	8.00– 4.45	8¾	20.1	.33	
16	8.00– 4.50	8¾	15.9	.23	Slight wind from west.
17	8.20– 4.50	8½	15.8	.20	Smoke blown up channel.
18	7.00– 3.00	8	15.8	.00	Wind from north and northeast.
19	7.00– 3.30	8½	17.7	.10	
20	7.25– 4.55	9½	17.7	.60	Wind from north and northeast in the morning; from smelter in afternoon.
21	7.30– 5.00	9½	20.2	1.25	Slight wind from direction of smelter.
24	8.00– 4.45	8¾	18.3	.12	Wind from northwest.
25	8.00–11.00	3	8.3	.00	
27	9.00– 4.45	7¾	16.2	.71	Northwest in forenoon; west in afternoon.
28	7.30– 4.30	9	20.1	1.38	Northwest in forenoon; slight west wind in afternoon.
29	7.30– 4.30	9	20.4	.82	Strong west and southwest wind.
31	7.35– 4.35	9	17.8	.23	Slight southwest or southeast wind.

NOVEMBER, 1913.

3	9.15–5.15	8	16.4	0.18	Southwest wind.
5	7.30–4.15	8¾	18.5	.00	South or southwest wind.
6	7.30–4.15	8¾	18.3	.04	South or northwest wind.
7	7.30–4.30	9	18.3	.18	Southeast wind.
8	7.00–3.00	8	16.2	.10	North or northeast wind.
10	9.00–4.50	7¾	16.4	.00	Smoke along channel and bluffs to east.
11	7.30–4.30	9	18.4	.08	South or southeast wind.
12	8.30–4.30	8	16.5	.02	Southeast wind.
13	8.30–4.15	16½	25.7	.05	Northeast wind.
14	8.00–4.30				Southeast wind.
17	9.00–4.45	16½	32.7	.16	Variable; seldom toward station.
19	8.00–4.30				
20	7.30–4.30	17	30.3	.19	Brisk general northwest wind.
21	8.30–4.30				
22	8.00–4.15	8½	14.2	.45	Moderate west wind.
24	9.00–4.30	21	40.2	.14	South or southeast wind.
25	8.00–3.00				
26	8.30–3.00				
28	2.00–5.00	3	5.7	.00	Slight northwest breeze.
29	8.30–2.00	12	22.8	.06	Northwest or north wind.
30	10.00–4.30				

Results of total-sulphur determinations made at station 2—Continued.

MARCH, 1914.

Day of month.	Time.	Hours.	Volume of sample.	Total sulphur calculated to parts of SO_3 per million parts of air.	General wind conditions.
			Cubic feet.		
19	8.45–5.45	9	10.0	0.10	East wind.
20	8.20–5.15	9	10.0	.16	West wind; smoke path AOC.[a]
21	8.30–3.45	7	14.0	.00	West wind; smoke path AOC.[a]
23	10.10–5.30	7	14.0	.00	Slight west wind; smoke path AOC.[a]
24	8.10–5.20	9	20.0	.05	Brisk west wind.
25	8.20–5.25	9	20.0	.05	Brisk southwest wind.
26	8.20–5.25	9	21.0	.11	Brisk northwest wind.
27	8.20–5.20	9	20.5	.28	West and northwest wind.
28	8.25–5.25	9	20.0	.00	Southwest wind.
29	8.50–5.20	8½	20.5	.44	Southwest and southeast wind.
30	8.25–4.15	8	18.3	.24	Southeast and southwest wind.
31	8.25–4.50	8½	18.3	.33	Southeast wind.

APRIL, 1914.

1	8.35–5.20	9	20.3	0.25	East wind.
2	8.35–5.15	8½	20.0	.18	East and slightly west wind.
3	8.35–2.00	5½	14.0	.19	Slight southwest wind.
4	9.25–3.55	6½	16.0	.25	Strong southeast wind
6	9.30–5.25	8	18.0	.26	Slight southwest wind.
7	9.10–5.20	8	16.0	.25	Slight west wind, along path AOC.[a]
8	8.35–5.20	9	20.0	.17	Slight southwest and east wind.
9	8.35–5.20	8½	18.0	.06	Strong southwest or west wind.
10	8.35–5.20	9	20.0	.04	Strong west wind; path AOC.[a]
11	8.30–5.30	9	20.0	.04	Slight west wind; path AOC.[a]
12	8.45–5.20	8½	20.0		
13	8.30–5.30	9	20.0	.12	Do.
14	8.40–3.10	6½	14.0		
17	8.50–5.25	8½	18.0	.14	Southeast wind; path AOC.[a]
18	8.40–3.40	7	18.0		
20	10.20–5.25	7	16.0	.11	Strong west and southwest wind.
21	8.40–5.10	8	20.0		
22	8.35–5.10	8½	20.0	.07	Strong west wind.
23	8.45–5.15	8½	20.0		
24	8.40–5.20	8½	20.0	.03	Do.
25	8.30–5.20	9	20.0		
26	8.30–4.05	7½	18.0		Do.
27	8.45–5.30	8½	20.0		Do.
28	8.35–5.25	9	20.0	.13	Do.
29	8.40–5.25	9	20.0		Slight east wind.
30	8.20–5.20	9	20.0		Do.

MAY, 1914.

1	8.35–5.00	8½	20.0	0.06	Strong west and northwest wind.
2	8.40–3.45	7	18.0		
4	10.30–5.10	6½	14.0	.15	Strong west wind.
5	8.50–5.15	8½	20.0		
6	8.40–5.00	9¼	20.0	.11	Do.
7	5.30–1.50	8¼	20.0		
8	8.40–5.00	9¼	20.0	.23	Do.
9	5.30–1.50	8¼	20.0		
10	8.40–5.50	9¼	20.0	.50	Slight west wind.
11	5.40–2.20	9	20.0	.55	Do.
12	9.15–5.20	8	18.0	.13	Strong west wind.
13	5.30–2.00	8½	20.0		

[a] See Plate VI.

Total-sulphur determinations at station 2, classified according to wind conditions.

WIND FROM THE WEST, AND THE SMOKE, DURING PART OF THE SAMPLING PERIOD, HEADED DIRECTLY TO STATION IN PATH COD.[a]

Date.	Rate of sulphur elimination from smelter per 24 hours.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average SO_2 content of "instantaneous" samples.	Date.	Rate of sulphur elimination from smelter per 24 hours.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average SO_2 content of "instantaneous" samples.
	Tons.				*Tons.*		
Sept. 18	32	1.30	1.25	Oct. 21	16	1.25	0.80
Sept. 20	31	1.20	.25	Oct. 27	40	.71	.80
Sept. 22	26	1.50	1.05	Oct. 28	40	1.38	1.25
Sept. 26	17	.85	1.15	Oct. 29	38	.82	.80
Oct. 9	11	1.03	.55	Nov. 22	36	.45	.35
Oct. 10	21	.83	.55	Apr. 2	23	.18	.22
Oct. 13	14	.37	.30	May 8	36	.23	.25
Oct. 14	16	.43	.50	May 9	25		
Oct. 15	14	.33	.20	May 10	38	.50	.40
Oct. 16	2	.23	< .20	May 11	45	.55	.65
Oct. 20	8	.60	.65				

WIND FROM THE WEST, AND SMOKE CONFINED MOSTLY TO PATH AOC.[a]

Oct. 17	18	0.20	<0.20	Apr. 11	28	0.04	<0.20
Oct. 24	13	.12	.20	Apr. 12			
Oct. 25	9	.00	< .20	Apr. 13	20	.12	< .20
Nov. 6	11	.04	< .20	Apr. 14			
Nov. 10	33	.00	< .20	Apr. 22	27	.07	< .20
Nov. 20	22	.19	.25	Apr. 23			
Nov. 21	35			Apr. 24	29	.03	< .20
Nov. 28	.....	.00	< .20	Apr. 25			
Nov. 29	39	.06	< .20	Apr. 26	.....	.....	.....
Nov. 30	33			Apr. 27	.....	.....	.....
Mar. 20	24	.16	< .20	Apr. 28	24	.13	< .20
Mar. 21	31	.00	< .20	May 1	.....	.....	.....
Mar. 23	19	.05	< .20	May 2	25	.06	< .20
Mar. 24	18	.05	< .20	May 4	.....	.....	.....
Mar. 26	22	.11	< .20	May 5	29	.15	< .20
Mar. 27	28	.28	< .20	May 6	41	.11	< .20
Apr. 7	27	.25	< .20	May 7			
Apr. 10	27	.04	< .20	May 12	36	.13	.30
				May 13			

GENERAL WIND DIRECTION FROM OTHER QUARTERS THAN THE WEST.

Oct. 11	17	0.29	0.20	Mar. 25	21	0.05	<0.20
Oct. 18	17	.00	< .20	Mar. 28	24	.00	< .20
Oct. 19	10	.10	< .20	Mar. 29	20	.44	< .20
Oct. 31	11	.23	< .20	Mar. 30	30	.24	< .20
Nov. 3	19	.18	.20	Mar. 31	20	.33	< .20
Nov. 5	19	.00	< .20	Apr. 1	23	.25	< .20
Nov. 7	14	.18	< .20	Apr. 3	27	.19	< .20
Nov. 8	11	.10	< .20	Apr. 4	25	.25	< .20
Nov. 11	12	.08	< .20	Apr. 6	28	.26	< .20
Nov. 12	14	.02	< .20	Apr. 8	32	.17	< .20
Nov. 13	18	.05	< .20	Apr. 9	31	.06	< .20
Nov. 14	18			Apr. 17	21	.14	< .20
Nov. 17	17	.16	< .20	Apr. 18	25		
Nov. 19	16			Apr. 20	27	.11	< .20
Nov. 24				Apr. 21	23		
Nov. 25	.....	.14	< .20	Apr. 29	23	.13	< .20
Nov. 26				Apr. 30	26		
Mar. 19	27	.10	< .20				

[a] See Plate VI.

Total-sulphur determinations made by automobile laboratory inside Benicia city limits.

Date.	Place.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average SO_2 content of instantaneous samples.	General wind notes.
1913.				
Sept. 17	Fisher's	1.02	0.60	Gentle west wind.
Sept. 18	Carty's	.00	.20	Gentle west to northwest wind.
Sept. 24	Fisher's	.40	.35	Moderate west wind.
Sept. 25	West end of G Street	.43	.70	Do.
Sept. 27	.....do	.47	.30	Do.
Oct. 4	Carty's	.20	<.20	Moderate west and northwest wind.
Oct. 6	Shipyard	.10	<.20	Light southwest wind.
Oct. 7	K and Main Streets	.15	<.20	Light west or southwest wind.
Oct. 8	Rose Place	.40	.30	Light west wind.
Oct. 8	Anderson Hotel	.60	.....	Do.
Oct. 9	.....do	.10	<.20	Moderate west wind.
Oct. 10	Shipyard	.65	<.20	Very light west wind; calm.
Oct. 14	Passalacqua	.15	.40	Do.
Oct. 15	Schoolhouse	.20	<.20	Do.
Oct. 16	Passalacqua	.20	<.20	Do.
Oct. 17	K Street near Prince's	.25	.20	Do.
Oct. 20	Benicia wharf	.00	<.20	Northwest wind.
Oct. 22	Eben Selby	.35	.30	Light west wind.
Oct. 24	Carty's	.05	<.20	Do.
Oct. 25	Shipyard	.00	.20	Do.
Oct. 27	Dana	.77	.35	Do.
Oct. 28	Cemetery	.15	<.20	Do.
Oct. 29	Carty's	.30	<.20	Strong west wind.
Nov. 4	Shipyard	.20	<.20	Calm or slight west wind.
Nov. 7	City wharf	.75	<.20	East wind (smoke from Mountain Copper Co.).
Nov. 8	Burke's saloon	.05	<.20	Slight west wind; strong.
Nov. 9	Anderson Hotel	.10	<.20	Strong west wind.
Nov. 19	Tannery	.30	<.20	Light northwest wind.
Nov. 21	Anderson Hotel	.30	<.20	Light west wind.
Nov. 22	Tannery	.00	<.20	Strong west wind.
Nov. 25 Nov. 26	Arsenal	.30	<.20	East wind (smoke from Mountain Copper Co.).

Number of tests, 31.
Total hours, 196.
Average parts of SO_2 per million parts of air proportional to hours, 0.28.
Average parts of SO_2 per million parts of air proportional to tests, 0.28.
Maximum SO_2 content, parts per million parts of air, 1.
Average parts of SO_2 per million parts of air from instantaneous samples, less than 0.20.

Total-sulphur determinations made by automobile laboratory in the farming districts between Benicia and Vallejo.

Date.	Place.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average parts of SO_2 per million parts of air, instantaneous samples.	General wind notes.
1913.				
Sept. 30	Rose house	0.15	0.53	North wind, then west.
Oct. 2	Brazil's house	.35	.24	Light west wind.
Oct. 3	Rose house	.10	<.20	Strong west wind.
Oct. 5	Dos Reis Cove	.30	<.20	Strong southwest wind.
Oct. 13	.....do	.15	<.20	Do.
Oct. 30	Clynes Cove	.40	<.20	Strong northwest wind.
Nov. 3	Midway saloon	.35	<.20	Calm.
Nov. 5	Dos Reis house	.20	<.20	Strong southwest wind.
Nov. 6	Brazil's house	.05	<.20	Light west or southwest wind.
Nov. 17	Dos Reis house	.15	<.20	Light southeast wind.

Total number of tests, 10.
Total number hours during tests, 54½.
Average parts of SO_2 per million parts of air, proportional to hours, 0.22.
Average parts of SO_2 per million parts of air, proportional to tests, 0.40.
Average parts of SO_2 per million parts of air, instantaneous samples 0.22.

SULPHUR DIOXIDE PRESENT IN THE ATMOSPHERE OUTSIDE THE SELBY SMOKE ZONE.

"Instantaneous" samples for SO_2 determinations were taken in the following sections:

1. Ocean Beach, San Francisco.
2. Business section, San Francisco.
3. Oakland and Berkeley.
4. Richmond and vicinity.
5. Martinez and Avon (i. e., in smoke zone of the Mountain Copper Co.).

DETERMINATIONS OF SULPHUR DIOXIDE PRESENT IN AIR AT OCEAN BEACH, SAN FRANCISCO, CAL.

Fifteen samples were taken along the Beach Road, south of the Cliff House, on September 1, 3, and 11, 1913, when there was a strong wind blowing off the ocean. None of these 15 samples contained determinable quantities of sulphur dioxide, there being present less than 0.2 part of SO_2 per million parts of air.

DETERMINATION OF SULPHUR DIOXIDE PRESENT IN ATMOSPHERE IN SAN FRANCISCO.

A total of 173 determinations were made in San Francisco. The average result was 0.3 part of SO_2 per million parts of air, the maximum being 1.8 parts per million parts of air. Between September 1 and 15, 1913, 74 determinations were made by A. E. Wells. At this period the air of the city was extremely smoky or foggy during the early morning hours. Along about the middle of the forenoon each day a slight westerly breeze would start to blow, gradually increasing in strength until at noon it would be brisk. As the wind velocity increased the smoke and fog were dissipated, and after 11 o'clock each day the air was very clear. The comparatively calm wind conditions in the early morning hours allowed an appreciable increase of the sulphur dioxide content of the air from the combustion of fuel in the city. Thus, the samples taken early in the morning contained the greatest amounts of sulphur dioxide. The sample containing the highest sulphur dioxide content (1.80 parts SO_2 per million parts of air) was taken at 9.30 a. m. on September 3, just north of the Southern Pacific tracks near Third and Townsend Streets. At the time this sample was taken the air was nearly calm and very smoky. At 10 a. m. the wind started to blow slightly, clearing the atmosphere somewhat, and the sulphur dioxide content decreased to 0.75 part per million parts of air. At noon the sulphur dioxide content was 0.30 part per million parts of air.

Again on September 6 the same atmospheric conditions existed as on the 3d. Samples were taken near the warehouse of the Pacific

Hardware & Steel Co., near King and Eighth Streets. The first two samples taken contained 1.60 parts of SO_2 per million parts of air. By 11 a. m. a west wind had sprung up, the air became clearer, and the sulphur dioxide content decreased. At 1 p. m. the sulphur dioxide content was only 0.20 part per million parts of air.

During February and March, 1914, determinations were made in San Francisco by Mr. G. N. Libby. During this period there were several mornings when the air was calm, and at these times the sulphur dioxide content was found to be as high as 0.75 part per million parts of air.

Summarized briefly, the sulphur dioxide content of the air in the business section of San Francisco was found to be as high as 1.80 parts per million parts of air during calm, smoky conditions. Under ordinary wind conditions, the sulphur dioxide did not average more than 0.30 part SO_2 per million parts of air.

Summary of tests in business section of San Francisco.

[Total number of tests, 173; average parts SO_2 per million parts of air, 0.29.]

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	79	45.7
.2 to .4	50	29.0
.4 to .6	23	13.3
.6 to .8	16	9.2
.8 to 1.0	2	1.1
1.0 to 1.5	1	.6
1.5 to 2.0	2	1.1
	173	100.0

Detailed results of tests in business section of San Francisco.

SEPTEMBER, 1913.

Day of month.	Place.	Notes.	Number of samples.	Parts of SO_2 per million parts of air.	
				Average.	Maximum.
3	North of Southern Pacific tracks, Third Street.	Smoky at first, clearing later	5	0.80	1.80
3	Appraisers' building	Clear	2	.30	.30
4	do	do	2	.35	.40
5	Corner second and Harrison Streets.	Slightly smoky	10	.30	.50
5	China Basin	Generally clear, occasional engine smoke.	10	.50	.80
6	Warehouse, Pacific Hardware & Steel Co.	Smoky	9	.73	1.70
6	Near gas tanks, Embarkadero	do	2	.90	1.00
8	do	do	6	.25	.55
8	Viaduct, east of Southern Pacific yards.	do	8	.40	.65
9	Appraisers' building	Clear	10	.35	.50
15	Corner Harrison and Sixteenth Streets.	Smoky	5	.60	.80
15	Top of hill, Eighteenth Street	Clear	5	.20	.20
			74	.45	.....

Detailed results of tests in business section of San Francisco—Continued.

FEBRUARY, 1914.

Day of month.	Place.	Notes.	Number of samples.	Parts of SO_2 per million parts of air.	
				Average.	Maximum.
11	Appraisers' building	Calm, smoky	6	0.35	0.75
11	Corner Sixteenth and Illinois Streets.	Calm, clear	6	.30	.75
			12	.30	.....

MARCH, 1914.

3	On Arkansas Street, west of General Electric Co. plant.	Light southeast wind	4	<0.20	<0.20
3	Corner Kentucky and Fifteenth Streets.	do	3	< .20	< .20
4	King and Fourth Streets	do	4	< .20	.50
4	Corner Seventeenth and Mississippi Streets.	Clear	10	< .20	< .20
5	Corner Fifteenth and Potrero Streets.	Smoky at the start, clearing	5	.25	.50
5	Corner Fifteenth and San Bruno Streets.	Calm	7	< .25	.50
6	Fifteenth Street, between Potrero and San Bruno.	Northeast wind	14	< .25	.50
7	Seventh and Berry Streets at Southern Pacific tracks, near Scott, Magner & Miller.	Calm	13	.40	.75
10	Corner Sixteenth and Bryant Streets.	West wind, clear	15	< .25	< .25
19	Near gas works on East Street	West wind	12	< .25	.50
			87	< .20	.....

Examples of variation of sulphur dioxide content of the air during the day in San Francisco.

SEPTEMBER 3, 1913.

DETERMINATIONS MADE NORTH OF THE SOUTHERN PACIFIC CO.'S TRACKS, BETWEEN THIRD AND FOURTH STREETS.

Time.	Notes.	Parts of SO_2 per million parts of air.
a. m.		
9.30	No wind; very smoky	1.80
10.05	Slight southwest wind; slightly smoky	.70
10.30	Slight southwest wind; clearer air	.80
11.05	Moderate west wind; clear	.25
p. m.		
12.25	Brisk west wind; clear	.40

DETERMINATIONS MADE AT APPRAISERS BUILDING.

p. m.		
2.05	Brisk west wind; clear	0.30
4.30	Do	.30

Examples of variation of sulphur dioxide content of the air during the day in San Francisco—Continued.

SEPTEMBER 6, 1913.

DETERMINATIONS MADE NEAR WAREHOUSE OF PACIFIC HARDWARE & STEEL CO. NEAR INCINERATOR.

Time.	Notes.	Parts of SO_2 per million parts of air.
a. m.		
10.55	Very slight east wind; very smoky	1.70
11.10	Do	1.40
11.45	West wind springing up; clearer	.70
12.00	Do	.70
p. m.		
12.25	Brisk west wind; clear	.40
12.45	Do	.50
12.55	Do	.40
1.05	Do	.30
1.25	Do	.40

DETERMINATIONS MADE IN OAKLAND AND BERKELEY.

During January and February 148 determinations were made in Oakland and Berkeley. The maximum sulphur dioxide contamination (1 part SO_2 per million parts of air) was found in the path of the smoke from the Southern Pacific Co.'s roundhouse and near the gas plant near Market and First Streets. Outside the line of smoke from this source the air was found to contain less than 0.2 part of SO_2 per million parts of air.

Summary of results of tests made in Oakland and Berkeley.

[Number of tests, 148; average SO_2, less than 0.20 part per million parts of air.]

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	117	79.0
.2 to .4	19	12.8
.4 to .6	8	5.4
.6 to .8	2	1.4
.8 to 1.0	2	1.4
	148	100.0

Detailed results of tests made in Oakland and Berkeley.

DECEMBER, 1913.

Day of month.	Place.	Notes.	Number of samples.	Parts of SO_2 per million parts of air.	
				Average.	Maximum.
23	Grant Street, Berkeley	Slight west wind	12	<0.20	0.20

Detailed results of tests made in Oakland and Berkeley—Continued.

JANUARY, 1914.

Day of month.	Place.	Notes.	Number of samples.	Parts of SO_2 per million parts of air.	
				Average.	Maximum.
2	In line Southern Pacific R. R. Co. roundhouse smoke, near Adeline Street.	Light south wind	3	0.70	1.00
2	One-half block north of gas works on Market and First Streets.	do	8	.60	1.00
3	Center and Third Streets	Southeast wind; clear	5	<.20	<.20
3	Third and Linden Streets, near gas plant, under smoke.	Light southeast wind; clear	6	.20	.80
3	Market and Seventh Streets	do	10	<.20	.20

FEBRUARY, 1914.

1	Alameda Bridge	Very clear day; smoke high; west wind.	14	<0.20	<0.20
3	Near Southern Pacific Mole and corner Jefferson and Third Streets.	Smoke high; wind south and west.	12	< .20	< .20
4	Third and Clay Streets. Under Southern Pacific and gas plant smoke.	Wind south and west	17	.20	.60
5	Harrison and Third Streets	Light west wind; clear	12	< .20	< .20
6	University Avenue and Berkeley Pier.	Northwest wind	8	< .20	< .20
7	Corner Third and Franklin Streets.	West wind; clear	14	< .20	< .20
16	First and Grove Streets	West wind; cloudy	11	< .20	.50
17	Fifth and Market Streets; Twelfth and Chestnut Streets; Twelfth and Bay Streets.	South wind; smoke high	16	< .20	< .20
			148	< .20	1.00

DETERMINATIONS MADE IN RICHMOND AND VICINITY.

The Standard Oil refinery at Point Richmond discharges a large volume of smoke into the atmosphere. Under very light wind conditions this smoke hangs as a cloud over Point Richmond or drifts eastward over Richmond and San Pablo.

Determinations were made at Point Richmond, Richmond, and San Pablo to determine the sulphur dioxide content of the atmosphere. A summary of the data from Point Richmond is given below. The data show that in the direct path of the smoke, within a distance of 1 mile, a comparatively high concentration, as high as 4.5 parts SO_2 per million parts of air was found. It is also to be observed that even when the smoke was not noted as being in the vicinity, the atmosphere contained determinable quantities of sulphur dioxide, averaging 0.40 part SO_2 per million parts of air. In the city of Richmond proper and San Pablo the highest concentration of sulphur dioxide found was 1.8 parts per million parts of air.

Summary of results of tests in Richmond and vicinity.

POINT RICHMOND, SOUTH OR WEST OF STANDARD OIL REFINERY.

Date.	Number of samples.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.
Dec. 6	13	0.30	0.60
Dec. 8	21	1.45	3.60
Dec. 9	20	1.20	3.40
Dec. 15	24	2.00	4.50
Dec. 16	15	.30	2.40
Dec. 18	10	.40	1.00
	103	1.10	.....

The results of the above 103 tests have been segregated as follows: Tests with refinery smoke in vicinity (within 1-mile range); tests with refinery smoke not in the vicinity, or high overhead.

Segregation of results of tests in Richmond and vicinity.

RESULTS OF TESTS WITH REFINERY SMOKE IN VICINITY (WITHIN 1-MILE RANGE).

Date.	Number of samples.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.
Dec. 8	21	1.45	3.60
Dec. 9	15	1.50	3.40
Dec. 15	14	3.20	4.50
Dec. 16	2	1.70	2.40
	52	1.95	.....

RESULTS OF TESTS WITH REFINERY SMOKE NOT IN VICINITY, OR HIGH OVERHEAD.

Date.	Number of samples.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.
Dec. 6	13	0.30	0.60
Dec. 9	5	.20	.30
Dec. 15	10	1.00	1.40
Dec. 16	13	<.20	.40
Dec. 18	10	.40	1.00
	51	.40	.....

RESULTS OF TESTS AT RICHMOND AND SAN PABLO, IN LINE OF SMOKE.

Date.	Number of samples.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.
Dec. 17	19	0.60	[a] 1.80
Dec. 22	14	1.20	[b] 1.80

[a] Three-fourths of a mile to 2 miles from plant.
[b] One to 2 miles from plant.

DETERMINATIONS MADE IN MARTINEZ OR VICINITY, IN THE SMOKE ZONE OF THE MOUNTAIN COPPER CO.'S PLANT.

The Mountain Copper Co.'s plant at Rococo, near Martinez, is situated very favorably for operation without maintaining a smoke nuisance. The plant is located at Suisun Point on Suisun Bay, about 1 mile northeast of Martinez. The smokestack is built on a hill and the smoke is discharged at a considerable height above the surrounding country. During the season of the trade winds, the smoke is generally blown over the tule lands or Suisun Bay to the east or northeast. Only during an occasional north or northeast wind is the smoke from this smelter blown toward Martinez.

In order to determine the concentration of the sulphur dioxide in the air around Martinez and the vicinity, 168 tests were made on 12 days during the investigation periods of the commission. A summary of the data so obtained is given below.

The highest concentration found was only 1.7 parts SO_2 per million parts of air. This was found at a point 1½ miles south of the smelter at a time when the smoke was observed by sight to be in the immediate vicinity. At no time was the SO_2 in the smoke of the Mountain Copper Co.'s plant detected by smell by any of the field men.

The data obtained in this smoke district have been segregated below into three heads, as follows:

(*a*) Determinations made in the smoke stream from the Mountain Copper Co.'s plant.

(*b*) Determinations made when the smoke was blown high overhead at sampling point.

(*c*) Determinations made when the smoke was blown in general direction toward the sampling point.

General summary of results of determinations made at Martinez and Avon—In the smoke zone of the Mountain Copper Co.'s plant.

[Total number of tests, 168; average number of parts of SO_2 per million parts of air, 0.23; maximum number of parts of SO_2 per million parts of air, 1.70.]

Point of sampling.	Number of samples.	Parts of SO_2 per million parts of air.	
		Average.	Maximum.
In smoke stream	10	0.85	1.70
Under smoke stream	121	.20	1.20
In direction of smoke stream	37	< .20	.50
	168	.....	.....

General summary of results of determinations made at Martinez and Avon—In the smoke zone of the Mountain Copper Co.'s plant—Continued.

Limits of concentration (parts of SO_2 per million parts of air).	Number of samples.	Proportion of total.
		Per cent.
0.0 to 0.2	120	71.3
.2 to .4	17	10.2
.4 to .6	11	6.5
.6 to .8	10	6.0
.8 to 1.0	6	3.6
1.0 to 1.5	3	1.8
1.5 to 2.0	1	0.6
	168	.....

Detailed results of determinations made at Martinez and Avon—In the smoke zone of the Mountain Copper Co.'s plant.

IN SMOKE STREAM.

Date.	Place.	Distance from smelter.	Wind.	Number of samples.	Parts of SO_2 per million parts of air.	
					Average.	Maximum.
1913.						
Sept. 23	Martinez	1½ miles south	North	5	1.10	1.70
Nov. 2	Railroad Station	1 mile southwest	Northeast	2	.90	.90
1914.						
Apr. 29	Bulls Head Point	1 mile east	West	3	.40	.50
				10	.....	.....

UNDER SMOKE STREAM.

1913.						
Sept. 23	Martinez	1½ miles south	North	7	0.80	1.20
Oct. 1	Do	do	do	7	.25	.45
Oct. 11	Do	1½ to 2½ miles south	do	15	<.20	.20
Nov. 12	Martinez Station	1 mile southwest	Northeast	13	.30	.40
Nov. 13	Martinez Ball Park	Southwest	do	18	<.20	.40
1914.						
Apr. 18	Martinez between station and Concord Road.	1 to 2 miles south	do	15	<.20	.50
Apr. 29	On Martinez-Concord Road.	1 to 3 miles southeast and south.	North and northeast.	13	<.20	.50
May 6	Avon	3 miles east	West	21	.35	.75
May 7	Peyton	1 mile east	do	12	<.20	1.00
				121	.....	.....

IN DIRECTION OF SMOKE STREAM.

1913.						
Sept. 23	Martinez	1½ miles south	West	2	<0.20	<0.20
1914.						
May 5	Road to Concord	4 to 5 miles southeast	do	6	< .20	.20
May 6	Avon	3 miles east	Northwest	4	< .20	.20
May 7	Bay Point	5 miles east	Southwest	9	< .20	.20
May 8	Santo Fe track south of Avon.	3½ miles southeast	West	16	< .20	.20
				37	.....	.....

TOTAL-SULPHUR DETERMINATIONS OUTSIDE THE SELBY SMOKE ZONE.

The determinations of total sulphur content of the air in places outside the Selby smoke zone were made in the same manner and with the same apparatus as those made in the Selby district. As in the discussion of the sulphur dioxide determinations from "instantaneous" samples, the results will be discussed under the five divisions, as indicated below:

TOTAL-SULPHUR DETERMINATIONS MADE ON OCEAN BEACH IN SAN FRANCISCO.

Due to the fact that in the first set of absorption tubes used, there was some rubber exposed to the action of the bromine and ammonical vapors the solutions were "salted" slightly by sulphur dissolved from the rubber. Thus the first series of total sulphur samples taken in San Francisco were not considered reliable and were discarded. On September 13, 1913, two short total-sulphur determinations were made on the beach, which gave practically a zero value, and the apparatus was then considered free from any internal source of sulphur which could "salt" the samples.

RESULTS OF OTHER TOTAL-SULPHUR DETERMINATIONS.

The results of total-sulphur determinations are presented in the tabulation following:

Results of certain total-sulphur determinations made outside the Selby smoke zone.

DETERMINATIONS IN SAN FRANCISCO.

Date.	Place.	Volume of sample.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average number of parts of SO_2 per million parts of air, "instantaneous" samples.
1913.		*Cubic feet.*		
Sept. 15	Corner Harrison and Sixteenth Streets	6.8	0.90	0.60
Sept. 15	Top of Eighteenth Street hill	5.8	.17	< .20
1914.				
Feb 11	Various points	12.2	.55	.30
Mar. 4	Seventeenth and Mississippi Streets	14.0	.17	< .25
Mar. 5	Tenth and San Bruno, near Stauffer Chemical Co	30.6	.18	< .25
Mar. 6				
Mar. 7	Seventh and Berry Streets	20.2	.32	.25
	Average of 6 samples	.....	.38	.....

Results of certain total-sulphur determinations made outside the Selby smoke zone—Con.

DETERMINATIONS IN OAKLAND AND BERKELEY.

Date.	Place.	Volume of sample.	Total sulphur calculated to parts of SO_2 per million parts of air.	Average number of parts of SO_2 per million parts of air, "instantaneous" samples.
1914		*Cubic feet.*		
Jan. 3	Linden and Third Streets	14.1	0.38	<0.20
Feb. 1	Foot of Broadway	16.0	.19	< .20
Feb. 3	Near Southern Pacific roundhouse	16.2	.25	< .20
Feb. 4	Third and Clay Streets	18.1	.19	.20
Feb. 5	Harrison and Third Streets	18.1	.21	< .20
Feb. 6	West Berkeley	12.0	.11	< .20
Feb. 7	Third and Franklin Streets	18.2	.28	< .20
	Average	.....	.25	.....

DETERMINATIONS IN RICHMOND AND VICINITY.

1913				
Dec. 6	West of Standard Oil Refinery	11.0	0.70	0.30
Dec. 8	.....do	14.0	2.60	1.45
Dec. 15	.....do	14.0	2.20	2.00
Dec. 16	.....do	14.0	.55	.30
Dec. 22	.....do	12.0	2.60	1.20
	Average	.....	1.73	.....

DETERMINATIONS AT MARTINEZ [a] AND AVON, IN THE SMOKE ZONE OF THE MOUNTAIN COPPER CO.'S PLANT.

1913				
Oct 1	Martinez, 2 miles south of smelter	14.2	0.56	0.25
Nov. 12	Martinez railroad station	12.8	.90	.40
Nov. 13	.....do	14.6	.62	.40
1914				
Apr. 29	Various points	8.8	.35	< .25
May 6	Avon	12.5	.20	< .25
May 7	Peyton	14.2	.20	< .25
	Average of 6 samples	.....	.41	.....

[a] There was a wide difference between total SO_2 and average SO_2 determinations in Martinez.

COMPARATIVE RESULTS OF SO_2 DETERMINATIONS FROM "INSTANTANEOUS" SAMPLES.

As the tests for sulphur dioxide in San Francisco, Oakland, Richmond, and Martinez were not made under as wide a range of wind and other conditions as were the tests made in the Selby smoke zone, it is not strictly proper to compare the average concentrations found. However, the comparison of the maximum concentrations found may be of some value.

Comparative results of SO_2 determinations from "instantaneous" samples.

Location.	Parts of SO_2 per million parts of air.	
	Average.	Maximum.
San Francisco business section	0.29	1.80
Oakland	<.20	1.00
Point Richmond:		
In oil-refinery smoke	1.10	4.50
Outside refinery smoke	.40	1.80
Richmond city—In oil-refinery smoke	.90	1.80
Martinez	.23	1.70
Selby smoke zone:		
Benicia city	.20	2.40
Agricultural district	.24	7.10

Not many attempts have been made to determine the sulphur dioxide content of the air during a very short interval of time. The only other work that has been done along similar lines, the results of which have been published, is the work of Atherton Seidell and Philip W. Meserve. Their work was to determine the gaseous impurities in the air of railway tunnels, and is described in Bulletin 92, Hygienic Laboratory, United States Public Health Service.

In the Fulton Tunnel of the Pennsylvania Railroad, Baltimore, they found sulphur dioxide concentration varying between 0.2 part and 15.1 parts per million parts of air, with an average concentration of 5.1 parts. In the electrified tunnel of the Baltimore & Ohio Railroad, in the same city, the concentrations found varied between 0.3 part and 2.3 parts.

Comparative results of total-sulphur determinations.

Location.	Total sulphur calculated to parts of SO_2 per million parts of air.	
	Average.	Maximum.
San Francisco business section	0.38	0.90
Oakland	.23	.38
Richmond	1.73	2.00
Martinez, in smoke of Mountain Copper Co.	.47	.90
Selby smoke zone, Benicia city limits	.25	1.00
Agricultural area along the Vallejo-Benicia highway	.22	.40
Agricultural area close to straits	.29	1.50

TOTAL-SULPHUR DETERMINATIONS OF OTHERS.

As most of the work that has been done in the past to determine concentration of sulphur dioxide in the air was with a method similar to that used by this commission in determining the average total sulphur dioxide content of the air, it will be interesting to compare some of the results obtained. It must be remembered, however, that such comparisons are of little value in drawing conclusions concerning the relative smoke "nuisance" in the several places.

Baskerville [a] gave the SO_2 contents of the air in New York City:

Results of SO_2 determinations in air of New York City.

Place of sampling.	Parts of SO_2 per million parts of air.
Near a high stack in elevated part of the city	3.14
Various parks, maximum	.84
Railroad tunnels	8.54 to 31.50
Downtown district	1.05 to 5.60
Localities near a railroad	1.12 to 8.40

TESTS TO DETERMINE THE SENSIBILITY OF MAN TO SULPHUR DIOXIDE AT HIGH DILUTIONS.

One of the chief complaints against the Selby smelter by the residents of Solano County has been, and to some extent still is, that the Selby smoke, as it is blown or drifted over the smoke zone, was so offensive to the senses of smell and sight as to be a nuisance and a detriment to health. The smoke is alleged to produce disagreeable symptoms, such as difficult breathing, suffocation, coughing, choking, and even nausea. However, from the preceding data concerning the sulphur dioxide content of the air as determined by analysis at times when the claim was made that the smelter smoke was "smelled" by some of the complainants, it is evident that there was no definite relation between the concentrations of the sulphur dioxide gas and the complaints. Most of the complaints in Benicia were made at times when our field men found only the slightest traces of sulphur dioxide. The complaints from the people at Glen Cove or around the White Ranch were made at times when the highest concentrations were found.

None of our field men suffered any severe or especially disagreeable symptoms on the few occasions that the sulphur dioxide was smelled by them. The most disagreeable sensation was the irritation in the throat and slight tendency to cough.

Thus, in order to determine whether the concentrations found by field tests in Benicia could be responsible for the nuisance claimed, it was very essential for the commission to make an extensive series of tests, with many persons as subjects, to determine the effects produced by breathing known concentrations of sulphur dioxide.

As a first step in this endeavor it was necessary to determine the minimum concentration, or in other words, the maximum dilution, at which the sulphur dioxide may be detected by the sense of smell or taste or by any symptoms produced. By increasing the concentration above that point the effect of the sulphur dioxide on many people was studied up to a concentration at which the sulphur

[a] Baskerville, Charles, The smoke problem and the community: Jour. Ind. and Eng. Chem., vol. 2, August, 1910, p. 359.

dioxide was declared a positive nuisance. In the case of a few subjects the concentration was carried much higher, in fact, up to a concentration at which it was difficult to breathe the gas for more than a few seconds. These investigations were conducted in one of the rooms of the United States Bureau of Mines at the San Francisco customhouse. The apparatus and the method used for getting the known mixtures of sulphur dioxide and air were the same as used in the tests to determine the accuracy of the analytical methods. As described fully in the discussion of those tests, the method consisted of adding continuously a metered volume of sulphur dioxide to a known volume of air, which mixture was driven by a blower through a mixing box and pipes into a booth, in which a person could stand or sit in a normal position. Plate X, *B*, shows the arrangement of meter, fan, mixing box, and booth.

In the first determinations of this character the subject whose sensibility to sulphur dioxide was being determined was required to breathe the mixture as it was blown through a "smelling box" 12 inches square and 18 inches long, open at the end, before which the subject stood. Due to the fact that the subject was more or less influenced by the rush of air at quite high velocity into the face, it was thought advisable to have the subject sit or stand in a booth where, the air being comparatively quiet, the subject would be in a more passive state and less likely to be influenced by the imagination. Being in the booth and not allowed to see what changes were made by the operator, the subject was able to detect the changes only by the effect on himself, which served partly to eliminate the factor of imagination. In order to eliminate still further the factor of imagination, several tests were made while the subject, by reading or writing in the booth, tried to divert his attention to other things. The effects of the different concentrations were noted by the subject only when requested by the operator.

In order to determine the concentration at which the sulphur dioxide could first be recognized, the tests were carried out in a variety of ways. In most cases the concentration of sulphur dioxide in the air surrounding the subject was gradually increased from zero to any desired amount, the subject stating when the presence of the gas was suspected and when it was positively identified. As the concentration was gradually increased above the identification point, the effect of the gas on the subject was noted. In other cases the subject was brought directly from comparatively pure air outside the room into the booth containing a definite concentration of sulphur dioxide and the effects noted. Several tests were made in which the subject was surrounded by an atmosphere containing sulphur dioxide above

the detection point, and then either abruptly or gradually the concentration was decreased until the subject stated that the gas was not detected.

As a general rule, when a person went directly from a sulphur dioxide free atmosphere into one containing a mixture, the sulphur dioxide was identified at a slightly lower concentration than if the concentration had been raised gradually. For example, many subjects who could identify a faint trace of sulphur dioxide at 3.5 parts per 1,000,000 when the concentration was gradually raised to that degree could detect the gas at 3 parts when the concentration was raised abruptly from zero.

If the concentration was raised gradually to the point at which it just could be identified, and remained constant at that concentration, there arose a doubt in the minds of many subjects after a few minutes as to whether or not the sulphur dioxide was present, and only by having the concentration raised slightly could these subjects detect it again. Following this feature still further, it was found that if a subject was allowed to breathe a concentration above the point at which the sulphur dioxide was just plainly smelled, and the concentration was then decreased very gradually, the point at which the disappearance of the sulphur dioxide smell was noted was somewhat higher than the point at which its presence was first noted. On the other hand, if the sulphur dioxide was cut down rather abruptly from the above point, the smell or taste of the sulphur dioxide persisted in many cases even after the concentration was lower than the point at which the first smell was noted. This persistency of smell or taste was especially noticeable when the subject had been given a rather strong dose. In the following table the data given are those obtained by gradually increasing the sulphur dioxide concentration in the air breathed by the subject while seated or standing in the booth.

The total number of persons who were kind enough to aid in the tests was 60. As many of these subjects were tested several times, the total number of recorded tests was about 85. Of the 60 subjects, 32 were previously rather well acquainted with the smell of sulphur dioxide, being chemists, engineers, or men who at some time had had some experience with that gas. The remaining 28 were not well acquainted with the gas. This class of subjects included janitors, carpenters, insurance agents, clerks, stenographers, etc. Although it was not possible to classify all the subjects accurately under the two heads, in regard to their being or not being acquainted with the smell of sulphur dioxide, an attempt has been made in the two following tables to approximate that classification.

Results of tests of effects of SO_2 on persons.

PERSONS PREVIOUSLY ACQUAINTED WITH SULPHUR DIOXIDE SMELL.

Parts of SO_2 per million parts of air.	Effect on persons.			
	Did not detect SO_2.	Doubtful as to smell.	Faint smell or taste.	Plainly identified gas as SO_2.
1	32	.....	.....	.....
2	19	11	2	.....
3	6	5	13	8
4	2	3	6	21
5	1	.....	5	26
6	1	.....	2	29
8	1	.....	.....	31
10	1	.....	.....	31
12	.....	1	.....	31
16	.....	.....	1	31
20	.....	.....	.....	32

PERSONS NOT WELL ACQUAINTED WITH SULPHUR DIOXIDE SMELL.

1	28	.....	.....	.....
2	26	[a] 2	.....	.....
3	18	[a] 4	.....	6
4	14	[a] 4	.....	10
5	6	[a] 10	.....	12
6	2	[a] 6	.....	20
8	.....	[a] 2	.....	26
10	.....	[a] 1	.....	27
12	.....	.....	.....	28

[a] Did, however, detect faint smell or taste of something foreign.

Referring to the tabulation of the results obtained from those subjects who knew previously the smell of sulphur dioxide, it will be noted that no one could detect 1 part per million. In atmosphere containing 2 parts per million, 13 of the 32 (40 per cent) suspected the presence of something foreign in the air; 2 of them by sense of taste thought they recognized a faint trace of sulphur dioxide. With 3 parts per million, 26 of the 32 (80 per cent) realized the presence of an acid gas, 5 being doubtful as to its being sulphur dioxide, 13 detecting a faint trace, and 8 identifying it plainly as sulphur dioxide. At 4 parts per million, only 2 subjects were unable to detect the presence of an acid gas, these 2 being men who had spent much time in smelter-furnace gases and thus had become so accustomed to the sulphur dioxide gas as to be insensitive to it. Twenty-one identified it plainly as sulphur dioxide. At 5 parts per million, practically all subjects smelled the gas either plainly or faintly.

Referring to the results of tests on those not so well acquainted with the smell of sulphur dioxide, it is to be noted again that none detected 1 part per million, and only 2 detected any foreign smell at 2 parts of sulphur dioxide per million parts of air. With a concentration of 3 parts per million, 6 subjects identified sulphur dioxide as being "burning sulphur," and 4 "smelled something." It was not until the concentration was raised to 5 parts per million that the

greater proportion of this class of subjects detected the presence of a foreign odor, and at 6 or 7 parts per million practically all had identified the odor, upon suggestion, as that of "burning sulphur." Having familiarized this class of subjects with the smell of sulphur dioxide, on a second test they were found to be about as sensitive as the first class.

It was concluded that the average person, who knew the smell or taste of sulphur dioxide, could detect its presence in the atmosphere when the concentration was between 3 and 3.5 parts per million. The average person not well acquainted with the smell could detect the presence of sulphur dioxide when the concentration was between 4 and 5 parts per million.

The manner in which the sulphur dioxide was identified differed with different subjects. Some identified the gas by the taste and some by the smell. In only a few cases was any throat irritation caused by a concentration of less than 5 parts per million. In breathing a mixture of over 5 parts per million, however, the action of the sulphur dioxide on the throat was more and more apparent, and at 10 parts per million was sufficiently irritating to cause most subjects to feel slight discomfort and to cough. As the concentration was further increased the tendency to cough became more marked, and its action on the eyes produced watering of the eye.

The concentration that produced irritation, coughing, and eye watering varied greatly with the individual and the length of time during which the concentrations were maintained. Thus, the concentration that the average person would call a nuisance was difficult to determine. Not only were the varied susceptibilities and the time factor to be considered, but what was even more of a factor in determining the nuisance question was the mental attitude of the individual in regard to the smell. If one was inclined to call a slight smell of a foreign gas in the atmosphere a nuisance, then a concentration of from 3 to 4 parts per million would be a nuisance. If, however, one did not consider it a nuisance until the concentration was sufficiently high to cause disagreeable throat irritation or coughing, the nuisance point would be very much higher. For example, one of the chemists for the commission considered it a nuisance to breathe for even a few minutes more than 3 parts sulphur dioxide per million, the concentration just above that at which he could detect the gas. Another chemist for the commission could detect the sulphur dioxide at the same concentration (3 parts per million) but breathed an atmosphere of 20 parts for a considerable period of time without calling it a nuisance.

The psychological element influencing these figures was illustrated further in the fact that many subjects called a certain concentration

a nuisance on one day and on another day breathed a higher concentration for a much longer period of time without stating that it was disagreeable. The time factor, of course, is very great in determining what concentrations are nuisances. What one could readily breathe for periods of several minutes at intervals, without any disagreeable features, was an actual discomfort after a longer period of steady duration.

Thus, the conclusions arrived at by these tests to determine the concentration that may be considered a nuisance are very general.

With the exception of a few cases, no subjects thought that any concentration less than 5 parts sulphur dioxide per million, even if continued for a considerable length of time, could be considered a nuisance. Occasional short period whiffs of less than 5 parts per million certainly could not be considered a nuisance to anyone. Long-continued breathing of air containing slightly more than 5 parts per million would probably cause discomfort to most people, though occasional momentary whiffs of 5 to 10 parts per million would not be disagreeable. As a few breaths of a mixture containing more than 10 parts sulphur dioxide per million caused the greater proportion of the subjects to feel the throat irritation and coughing, such a concentration, even if present at long intervals, and for only a very short time would probably be called a nuisance by most people.

In order to study the effect of concentrations stronger than 20 parts sulphur dioxide per million a special series of tests were made with several interested chemists as subjects. At 20 parts the concentration was declared very disagreeable, causing very distinct throat irritation and after a few breaths caused a heavy feeling in the chest. As the concentration was raised to 50 parts the action of the gas on the eyes became more pronounced, the throat and chest irritation becoming more acute. However, it was possible for a person to breathe that concentration for several minutes. Concentrations as high as 150 parts sulphur dioxide could be breathed by several men for a period of several minutes, although the sensations produced were extremely disagreeable. When the concentration was raised to 500 parts per million the gas was so acutely pungent as to cause the sensation of suffocation, even with the first breath.

Thus, sulphur dioxide at great dilution can be recognized in one of the following ways: Acid taste; sharp, pungent odor; at higher concentration by irritation of throat membrane, causing coughing; irritation of eyes, causing watering; at still higher concentration, by acute irritation of eyes or throat, and by producing a sense of suffocation.

With no concentration of less than 50 parts per million was there produced any feeling of nausea, and the tendency to nausea with the highest concentrations was only slight.

The data obtained in these tests check very closely the data obtained by Lehmann.[a] These earlier data show that in an atmosphere containing 6.5 to 11.5 parts per million there was only moderate discomfort, as stinging of the nose, after 10 or 15 minutes. With 14 or 15 parts there was considerable discomfort, which could be borne for ½-hour periods. In an atmosphere containing 30 parts per million the conditions were almost unbearable.

RELATION OF THE HAZY AND SMOKY CONDITIONS SOMETIMES PRESENT IN THE SELBY "SMOKE ZONE" TO THE SMOKE FROM THE SELBY SMELTER.

Before the installation of the bag house for the sintering-machine gases, the Selby plant contributed visible smoke to the atmosphere. Under very light west wind conditions this smoke was visible over Glen Cove, Dillon Point, and even as far east as Benicia. At Glen Cove and Dillon Point the smoke was at times rather dense. From a distance it could be seen clearly, but only when it was especially dense was it noticeable close at hand.

At Benicia the smoke was never dense. Looking across the straits to Benicia from Porta Costa, the Selby smoke could be seen, occasionally, as a faint haze drifting over the town. Only on two or three occasions was it possible to tell that the smoke was present when the observer himself stood in the path of the smoke.

During the months of September and October, 1913, there were many days when the air all around Vallejo and Benicia was hazy and smoky. However, it was evident by a little study of the conditions that the Selby smoke was only a very small part of the total general haze.

On August 24, 1913, Mr. Dutton and the writer noted that the air in the vicinity of Vallejo and Benicia was very hazy and smoky, as was the case all over the adjacent country. They noted that the smoke from the Selby smelter on that day was only a very thin stream and was drifting in a southeasterly direction from the smelter over the Contra Costa hills.

The general haze noted on September 17, 1913, was dense all over the bay district, and was no worse in the Selby "smoke zone" than elsewhere.

On October 20, 1913, at 2.30 p. m. the wind which had been blowing from the north changed into the west, and a very dense bank of smoke came drifting along the straits clinging to the north side. A special trip was made by the writer to a point where the smelter smoke stack could be seen, and it was evident that the smoke from the single sintering machine then in operation at the smelter was only a

[a] Lehmann, K. B., Experimentelle Studien über den Einfluss technisch und hygienisch wichtiger Gase und Dämpfe auf dem Organismus. Archiv Hygiene, vol. 18. 1893, pp. 180-191.

very small portion of the dense bank of smoke. The greater portion appeared to come up along the east shore of San Pablo Bay. Samples were taken in the direct path of this smoke bank as it drifted into Benicia, which gave a concentration as high as 1.6 parts SO_2 per million and showed that the smelter smoke was a part of the smoke bank. Although this smoke bank was dense when viewed against the background of some hills, when the observer was directly in the path of the smoke it was not very perceptible.

On several days during the spring months of 1914, after the installation of the bag house which eliminated the posibility of the Selby plant contributing to the visible smoke, the smoky and hazy appearance of the air in the Selby "smoke zone" was still noted.

In this connection it may be well to bear in mind the fact that the Union oil refinery at Oleum and the Standard Oil refinery at Richmond discharge, at times, very dense smoke into the air. From analyses made in the vicinity of Richmond, it was found that the smoke from the Standard Oil refinery contained relatively high amounts of sulphur dioxide. If some of this smoke which drifted up the straits to Benicia on October 20, 1913, contained the smoke from the Standard Oil Co. or Union Oil Co., it is barely possible that some of the sulphur dioxide found in the atmosphere of Benicia at that time was due to the oil refineries.

At no other time, however, was there an indication of appreciable quantities of sulphur dioxide coming to Benicia from the oil refineries.

SUMMARY CONCERNING CONTAMINATION OF ATMOSPHERE IN SELBY "SMOKE ZONE" BY SULPHUR DIOXIDE FROM THE SELBY SMELTER, AND CONCLUSIONS AS TO WHETHER THIS CONTAMINATION CONSTITUTES A SOURCE OF NUISANCE TO PEOPLE RESIDING IN THE "SMOKE ZONE."

GENERAL CONDITIONS.

1. When the wind was from the west and blew the smoke from the Selby smelter over the areas referred to in this report as the "smoke zone," there was present in the air of this area a higher concentration of sulphur dioxide than was found when the wind was blowing from other directions. This concentration is higher than is normally present in the atmosphere outside of large cities.

2. Although at times there may have been appreciable contributions to this contamination from sources situated southwest or west of Selby, little evidence of sulphur dioxide from other sources was found during these investigations. The sulphur dioxide contamination was due mainly to the emanations from the Selby smelter. Only when the wind was blowing the smoke directly from the smelter over the area were the higher concentrations found.

3. The concentration of sulphur dioxide in the air was not entirely proportional to the sulphur dioxide output from the Selby smelter, for the concentration at any point was influenced to a great extent by the atmospheric conditions.

4. No indications were found of the presence of very high concentrations during the early morning hours. The highest concentrations were found in the samples taken about noon or in the early afternoon.

5. Under moderate or brisk wind conditions, the increase in sulphur dioxide concentration was not very great in any part of the "zone," a maximum of 1.25 parts of SO_2 per million parts of air being found when the smelter was sending out sulphur dioxide at the rate of 70 tons per day.

6. Under a very slight west or southwest wind or a drift of air from the smelter across the "smoke zone" the concentration at certain places became relatively rather high for short periods of time. These high concentrations were found only when there were puffs of smoke relatively undispersed or poorly dissipated drifting past the point of sampling.

7. These puffs of Selby smoke were not of long duration at any time and came only at infrequent intervals. They were present more often and with higher sulphur dioxide content over the land lying nearest the straits and west of Dillon Point than in the city limits of Benicia or over the agricultural area bordering along the Vallejo-Benicia highway. For that reason it is desirable to consider the conditions in the farming area close to the straits separate from the rest of the "zone."

SMOKE CONDITIONS IN BENICIA CITY LIMITS.

At no time during the period of field investigations of this commission has the smoke from the Selby smelter been present in the city of Benicia to such an extent as to constitute a nuisance.

This is fully established by the following facts:

Even under the worst wind conditions and with an output from the Selby plant varying up to a maximum of 90 tons of sulphur dioxide per day, the maximum concentration found in the city of Benicia was only 2.40 parts of SO_2 per million parts of air.

Whenever the concentration was above 1 part of SO_2 per million parts of air, which was found in 22 samples out of 2,841 (0.8 per cent) it was due to puffs of poorly dispersed or diffused smoke drifting into the city. The concentration was not observed to remain above that figure for more than a maximum period of 20 minutes at any one time. It may be possible that slightly higher concentrations were present momentarily when observers were not in the field.

The maximum concentration found in Benicia was only slightly greater than that found in the downtown section of San Francisco

on smoky mornings during September, 1913. Higher concentrations have been found in the smoke zone of the Standard Oil refinery at Point Richmond.

The tests to determine the sensibility of human beings to sulphur dioxide showed that the average person required to be surrounded by an atmosphere containing at least 3 parts of SO_2 per million parts of air before he could detect the presence of the gas either by smell or taste. The average person did not consider concentrations of 5 or 6 parts of SO_2 per million parts of air, lasting for several minutes, a nuisance. Assuming that there are many people in Benicia who are especially susceptible to the gas, and can smell concentrations as low as 2 parts of SO_2 per million parts of air, there was only one recorded instance of the concentration being sufficiently high for those people to smell the gas. It is possible that at one or more points there may have been concentrations about as high as 2.4 parts per million for brief periods, but as less than 1 per cent of the examinations made show concentrations higher than 1 part SO_2 per million, this is improbable.

If complaints had been made by the citizens to our field men at times when the maximum concentrations had been found by analysis it would be easier to believe that the people of Benicia were consistently highly susceptible to the effects of sulphur dioxide. However, as was shown above, complaints were made at times when only very low amounts of sulphur dioxide were present—amounts entirely too small to be smelled by the most sensitive. In fact some of the most insistent complaints were made at times when the wind was from a direction other than the west and it was not possible for the Selby smoke to be in the vicinity, and the sulphur dioxide, if present, was below the quantity we could determine—that is, 0.2 part SO_2 per million. Our field men smelled the smoke in Benicia only on two occasions and then for only a brief period and only slightly.

In view of the fact that determinations, made under all kinds of wind conditions, and with variable amounts of sulphur dioxide emanating from the Selby smelter, showed that there was very seldom in the air a concentration sufficiently high for even an especially susceptible person to detect the sulphur dioxide, and in view of the fact that the people of Benicia complained frequently of the smoke when it was not possible for the smoke to be in the vicinity, it is impossible to believe that the Selby smoke has constituted a nuisance at any time in the city of Benicia during this period. Further, it is reasonable to conclude that with an output as high as 100 tons sulphur dioxide per day from the Selby smelter there is little possibility of this sulphur dioxide causing a nuisance to the people residing in Benicia, although the smoke may be detected occasionally by smell for a brief period.

It should be noted that with concentrations up to 20 parts SO_2 per million, none of the subjects experimented upon experienced a feeling of nausea or any symptom other than an irritation of the throat and a tendency to cough. Thus it is evident that the symptoms of nausea, the smelling of "rotten eggs," "dead cats," or the "suffocating odor" as described by the people of Benicia can not be due to the smell of concentrations of sulphur dioxide gas that are present at rare intervals in the city, or in any part of the "smoke zone."

SMOKE CONDITIONS IN THE AGRICULTURAL DISTRICT.

The part of the agricultural district immediately bordering the shore of the straits, west of Southampton Bay, was the only part of the "smoke zone" that received the smoke in sufficient strength to permit the possibility of the sulphur dioxide being a nuisance. Back of the range of hills directly north of the straits the smoke was seldom present. Only on one day in this part of the "smoke zone" were samples taken that contained more than 1 part SO_2 per million. The smoke was never smelled by our field men in the part of the "smoke zone" back of the above-mentioned line of hills. However, here, as in other portions of the "smoke zone," the oil fumes were frequently smelled.

At times the smoke drifted into Elliott Cove and Glen Cove and along the hills east of Glen Cove, past station 2 on the White ranch, in sufficient strength for the sulphur dioxide to be detected by smell. As shown by the data given above, there were 16 days during the period of investigation when the smoke was observed by eye passing the station, and on 4 days (3 per cent of the days on which observations were taken) the sulphur dioxide was detected by smell. On one of these days the smoke was strong enough to be a possible nuisance for two periods totaling 35 minutes. On this day, under the worst possible wind conditions and with an output from the Selby plant as high as 80 tons of sulphur dioxide per 24 hours, the concentration was found to be 7.1 parts of SO_2 per million parts of air. This was the highest concentration ever found in the "smoke zone." This concentration, continued for several minutes, is sufficiently high to cause people sensitive to sulphur dioxide to feel an irritation of the throat and a tendency to cough. However, out of the 60 different people tested to determine their susceptibility to sulphur dioxide there were only two or three who considered short periods whiffs of concentrations of 5 to 10 parts per million as a nuisance.

If it be assumed that people especially sensitive to sulphur dioxide were at this station during the period of 117 days when samples were being taken there, they might have smelled the smoke on 7 days, or on 11 different occasions, for a maximum period at any time of about 25

minutes. If it be assumed that people with only average sensibility were present, then only on 4 days could the smoke have been smelled.

It must be conceded that in the vicinity of the White farmhouse, or Glen Cove and Elliott Cove, that there is a possibility of the sulphur dioxide from the smelter being in sufficient strength at times to be detected by the average person and to especially supersensitive persons to be a nuisance. However, these periods when the sulphur dioxide is present in these strengths are only few and far between during any season, and with the Selby output restricted to not over 100 tons sulphur dioxide per day should not be considered sufficient cause for a nuisance complaint.

CONCLUSIONS CONCERNING THE POSSIBILITY OF SULPHUR DIOXIDE FROM THE SELBY PLANT BEING A MENACE TO AGRICULTURAL PURSUITS IN THE "SMOKE ZONE."

With an output from the Selby smelter of less than 100 tons sulphur dioxide per day, the possibility of the gas being sufficiently strong and present often enough to do material damage to the vegetation growing in the "smoke zone" is very remote. However, it was shown in our fumigation experiments on growing barley[a] that any concentration of sulphur dioxide if applied for a sufficiently long time or in a sufficient number of short-time fumigations would do damage.

If the concentration of sulphur dioxide found during a total of 35 minutes at White's place on October 28, 1913, was present over a grain field during the growing season—that is, between February and early May—it is very probable that visible bleaching would have been produced. With this exception, however, it is safe to state that at no other place where the tests were made, nor at any other time, was the gas present in sufficient strength for a short time, or present in smaller concentrations for a sufficient number of repeated longer time fumigations to produce a visible bleach on the grain if applied during the growing season.

From the fumigation experiments it was found that there was no indication of "invisible injury" to grain to decrease the yield of the crop. Any injury sustained was always visible and, under certain conditions, a considerable amount of visible injury did not necessarily mean a decrease in the yield of the crop. Thus it is proper to conclude that as the Selby smoke is not likely to produce visible injury to the vegetation in the zone there is no danger of invisible injury taking place.

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[a] See Fumigation Experiments to Determine the Effect of Highly Diluted Sulphur Dioxide on a Growing Grain Crop, p. 213.

The writer personally conducted some experiments in Utah during this season to determine the relative susceptibility of grain crops and other field plants to sulphur dioxide. As a result it was shown that the grains—barley, oats, and wheat—are especially susceptible to sulphur dioxide as compared with other crops, as, for example, potatoes, corn, and beets. Thus it must be concluded that as the sulphur dioxide from the Selby smelter is not likely to do damage to grain crops in the "smoke zone" the other crops in that district are not in any danger of being damaged.

If the smoke from the Selby smelter was present over the area during the wet winter months as frequently, or in as concentrated a form, as was found on several occasions during the dry season—that is, during the season of the "trade winds"—it is quite possible, even probable, that with the Selby plant turning out sulphur dioxide at the rate of 100 tons per day there would occasionally be some visible injury to vegetation in the area close to Dos Reis, Elliott, and Glen Coves or on the White place. The possibility of such bleaching taking place in other sections of the smoke zone, however, is remote.

Considering the fact that it is not during the wet season that the smoke is present to any extent over the area, and that during the dry season it is present only on infrequent occasions in sufficient strength to do damage, it is right to conclude that the Selby smoke does not constitute a menace to the successful growing of crops in the smoke zone.

DETERMINATION OF THE DEPOSITION OF LEAD AND ARSENIC ON THE SOIL IN THE SELBY SMOKE ZONE.

Inasmuch as the roaster gases from the Selby plant were going out into the air unfiltered prior to April, 1914, and carried most of the lead and arsenic fumes produced in these furnaces, it is reasonable to suppose that there might have been an appreciable deposition of these fumes on the soil of the smoke zone. The tests used to determine the extent of such deposition were qualitative rather than quantitative. For this purpose pairs of glass plates were set up at three points in the district. These plates were 4 by 6 feet in area. One plate of each set was covered with a thin coating of glycerine or vaseline; the other was left clean. The plates were slightly elevated from the ground and set to face the direction of the smelter, at an angle of about 45 degrees from the horizontal.

Set 1 was placed at station 2, on the White ranch. Set 2 was placed near the house of Mr. Miles Carty, near the western end of the town, close to the Benicia-Vallejo road, and almost in a direct line from the smelter behind set 1. Set 3 was placed near the farmhouse on the Dana place, a point almost in the same line as No. 1 and No. 2.

HISTORY OF PLATE SAMPLES.

SET 1.

These plates were set up on October 28, 1913, and one plate was coated with glycerine on that date. On November 3 it was found that the heavy rains of November 1 and 2 had washed the plates clean. On this date one plate was coated with a heavy layer of vaseline. Although many heavy rains during the month of November kept the other dry plate clean and free from dust, at each time the samples were taken there was an appreciable amount of dust on the vaselined plate. The vaselined plate was cleaned and recoated about every five days. The samples were all put together for a composite. The total time that the plate was exposed and catching dust was 30 days during the fall and early winter of 1913. On March 30, 1914, these plates were set up again. A few days after being set up one of the plates was broken by stock running in the field. Thus, no data from the dry plate were obtained from this set. The other plate was kept covered with a thin coat of vaseline from April 1 to May 13, samples being taken from time to time by rubbing off this thin coat on strips of cotton cloth. The samples taken in April, when the roaster bag house at Selby was in operation, were put together. The two samples taken between May 1 and 13 were analyzed separately to determine the precipitation during the time when the plant was operating three sintering machines and a Ropp roaster, and the bag house was not being used.

The samples of set 1 were taken as follows: No. 1, November 3 to December 3, 1913, 30 days. No. 1*a*, April 1 to May 1, 1914, 30 days. No. 1*b*, May 1 to May 13, 1914, 13 days.

SET 2.

These plates were set up on October 28, 1913. The rains of November 1 and 2 washed both plates so that on November 3 there was nothing on them. One plate was coated then with a heavy layer of vaseline. The deposit on this plate was removed and the plate recoated on November 10, 13, 20, and 28, and December 3. On November 10 and 20 a slight deposit was found on the dry plate. To remove this deposit, the plate was smeared with vaseline and the vaseline then scraped off. The plates were left out over winter, one plate having a very heavy coating of vaseline. On March 15, 1914, the vaseline and deposit from the winter was removed and the plate given a fresh coat. As at set 1, the vaseline was only lightly smeared over the surface during the spring sampling, but as there was very little precipitation of rain during these months, this thin coating was undoubtedly effective in catching the dust. To remove the sample,

it was necessary to rub off the vaseline with a clean cotton cloth, the cloth being included with the sample in the subsequent analysis. As with the samples from set 1, those taken between March 15 and May 1 were put together into one sample, and the samples taken after May 1 were put onto a second composite sample.

The samples of set 2 were taken as follows: No. 2, November 3 to December 3, 1913, 30 days. No. 2*a*, December 3 to March 15, 1914, 102 days. No. 2*b*, March 15 to May 1, 1914, 46 days. No. 2*c*, May 1 to May 13, 1914, 13 days. No. 4, dry-plate sample.

SET 3.

Although these plates were set up on October 28, it was not until after November 3, when one plate was coated with vaseline, that any dust was collected. Samples were taken, and the plates were recoated on November 12, 20, and 28, and December 4. No good samples were taken from the dry plates, because the rains kept this plate well washed off. Early in the spring months these plates were broken by stock running in the field, and were not replaced.

Sample 3 was taken November 3 to December 4, 1913, 31 days.

DETERMINATION OF LEAD AND ARSENIC IN SAMPLES.

All of the samples containing the large excess of vaseline, namely, samples 1, 2, and 3, and the special sample taken from the dry plate at the Carty place (No. 4) were analyzed by Mr. C. E. Brandt, in the laboratory of Gould, Free & Ash. The samples taken on the cotton cloths, namely, Nos. 1*a*, 1*b*, 2*a*, 2*b*, and 2*c*, were analyzed by Mr. G. C. Bartells in the laboratory of the San Francisco office of the United States Bureau of Mines.

SAMPLES 1, 2, AND 3.

These samples were treated with petroleum ether to dissolve the vaseline. The residual solids were weighed. The solids were then divided, one part being used for the determination of lead and the other for arsenic. The part for the arsenic determination was treated directly in a Marsh apparatus, the resulting reduced arsenic was collected in a hard-glass tube, and the mirror compared with standard mirrors. The part for lead was treated with nitric acid, and then brought to fumes with sulphuric acid, the solution diluted and filtered. The lead sulphate was dissolved in ammonium acetate, and the lead precipitated as lead sulphide. This sulphide was then dissolved in nitric acid and the lead again precipitated as sulphate. After taking the solution to dense acid fumes the solution was diluted and the lead sulphate was filtered and weighed.

Results of analyses of samples 1, 2, 3, and 4 for determination of lead content.

Sample No.	Number of days' deposit.	Total dust.	Lead.	Arsenic.	Parts per million parts of total solids.	
					Lead.	Arsenic.
		Grams.	*Grams.*	*Grams.*		
1	30	0.8932	0.0037	0.0000085	4,150	10
2	30	1.075	.0028	.00004	2,600	37
3	32	1.200	.0010	.00006	800	50
4	[a] 20	.508	.0005	.000003	900	6

[a] Approximate.

Blanks were run on the vaseline. No lead was found, and arsenic was present to the extent of a very slight trace, which would amount to a correction of less than 1 part in 1,000,000, applied to the above results.

It is to be noted that the lead content of this dust is much greater than that found in the soil samples taken for the soil investigation of Mr. E. E. Free and Prof. Charles F. Shaw.

SAMPLES 1*a*, 1*b*, 2*a*, 2*b*, 2*c*.

These samples, consisting of a small amount of vaseline on a strip of cotton cloth, were first treated with nitric and sulphuric acid and the organic matter destroyed. The solutions were then heated to dense white fumes of sulphuric acid. The lead sulphate was then filtered, redissolved, and reprecipitated. The resulting pure lead sulphate was then weighed. No arsenic determinations were made on the samples.

Results of analyses of samples 1a, 1b, 2a, 2b, and 2c.

Sample No.	Number of days' deposit.	Quantity of lead in sample.
		Grams.
1a	30	0.0005
1b	13	.0022
2a	102	.0057
2b	46	.0000
2c	13	.00025

Comparison of rate of deposition on the dust-catching plates.

ROASTER BAG HOUSE NOT IN OPERATION.

Time.	Place.	Deposition per plate (area, 24 square feet) per day.		
		Total.	Lead.	Arsenic.
		Grams.	*Grams.*	*Grams.*
November, 1913	Set 1, White's	0.0297	0.000123	0.00000028
	Set 2, Carty's	.0359	.000093	.0000013
	Set 3, Dana's	.0375	.000037	.0000020
December, 1913, to March, 1914	Set 2, Carty's	.....	.000056	.....
May 1 to May 13, 1914	Set 1, White's	.....	.000170	.....
	Set 2, Carty's	.....	.000020	.....

ROASTER BAG HOUSE IN OPERATION MOST OF THE TIME.

April, 1914	Set 1, White's	.....	0.000017	.....
	Set 2, Carty's	.....	.000000	.....

SUMMARY OF RESULTS.

During November the rains were so frequent and so heavy that no dust could be obtained from the dry plates. Even from the thickly coated vaseline plates it is probable some of the dust was washed off by the rains. Thus the data from these plates during November were not very satisfactory and were far from being quantitative. However, there is no doubt that lead and arsenic were both deposited on the plates. About the same amount of total dust was collected on the different plates. The proportions of lead and arsenic in this dust varied. The dust collected on the plate at the White ranch contained the maximum lead, 4,150 parts of lead per million parts of total dust. The dust collected at the Carty place carried 2,600 parts per million. The lowest lead content was found in the dust collected at the Dana place, which carried only 800 parts lead per million.

The proportion of arsenic present in the samples was in the reverse order, the sample from the Dana place containing the largest amount, 50 parts per million, and the sample from White's containing only 10 parts. No explanation for this anomaly is evident.

It will be noted also that the total weight of dust collected on the plates was slightly greater at the Dana place than at the Carty, which in turn was greater than that collected at the White place.

During April the roaster bag house at Selby was not in continuous operation, owing to some troubles in operating details. Thus, some lead escaped at times. This fact undoubtedly explains why lead was found in the sample from the White place during that month.

In order that the rate of deposition at the several places and at different times may be readily understood, the comparative rate has been tabulated as shown below.

As the plates were placed at an angle of about 45° from the ground, the deposition was undoubtedly greater than would have been obtained upon horizontal plates. Thus, to base the deposition on the soil from the data of the deposition on these plates would be wrong. However, it is interesting to see what the deposition on the soil would amount to if equal to the deposition on these plates. The calculated deposition on the soil thus obtained is as follows:

Calculated deposition of dust at different places.

ROASTER BAG HOUSE NOT IN OPERATION.

Time.	Place.	Deposition per acre per year.	
		Lead.	Arsenic.
		Grams.	*Grams.*
November, 1913	White's ranch	82	0.2
	Carty's place	62	.8
	Dana's place	21	1.2
December, 1913, to Mar. 15, 1914	Carty's place	37	.....
May 1 to May 15, 1914	White's ranch	113	.....
	Carty's place	13	.....

ROASTER BAG HOUSE IN OPERATION MOST OF TIME.

Apr. 1 to May 1, 1914	White's ranch	10	.....
	Carty's place	0	.....

The addition of 113 grams lead per acre year to the top 2 inches of soil, assuming all the lead to remain there, would increase the lead content of that part of the soil by 0.4 part of lead per million parts of total weight.

In arriving at this figure, 3,500,000 pounds was used as the weight of an acre-foot.[a]

CONCLUSION.

When the roaster smoke was allowed to go out into the atmosphere unfiltered from the Selby plant there was undoubtedly a very slight deposition of lead on the soil of the "smoke zone." However, the amount so deposited was very small and would have required many years' deposition to bring about an appreciable increase in the lead content of the soil.

However, with the successful operation of both the bag houses there is no possibility of further deposition.

[a] Hilgard, E. W., Soils, 1906, p. 107.

DETERMINATION OF LEAD AND ARSENIC PRESENT IN THE GRASSES AND STRAW IN THE SELBY "SMOKE ZONE."

On November 30, 1913, the day before the first rains of the season, five samples of the dried and closely matted grasses were taken in the Selby smoke zone. The samples were taken by Mr. A. E. Wells along the front of the bluffs on the north side of the straits between station 2, at White's ranch, and Dead Mans Point. The grasses were dry and dusty, as no rain had fallen on them since early in the preceding summer. Thus they would contain the maximum amount of lead and arsenic that might be deposited from the smelter smoke. These samples were all united to make one composite sample.

The total weight of the samples was 354 grams. Five grams was used for the determination of arsenic. Two hundred and fifty-four grams was used for the lead determination. These determinations were made by Mr. C. E. Brandt in the laboratories of Gould, Free & Ash.

METHOD OF DETERMINING LEAD.

The sample, 254 grams, was digested with HNO_3 until decomposed, sulphuric acid was added, and the solution digested for many hours, nitric acid being added to keep up the oxidation until all organic matter was oxidized. The solution was then heated to copious evolution of SO_3 fumes, then cooled and diluted. The lead sulphate was filtered from the solution and purified by dissolving in ammonium acetate, and reprecipitated as sulphide. This sulphide was then dissolved and the lead reprecipitated as sulphate, which was weighed.

METHOD OF DETERMINING ARSENIC.

Five grams of the vegetation was treated directly in a flask with sulphuric acid and zinc, connected with the regular Marsh apparatus for collecting the arsenic. The amount of the arsenic collected was determined by comparing the mirrors with standard mirrors.

RESULTS OF DETERMINATIONS.

The results of the determinations were as follows:

Lead.—Weight of lead found in 254 grams vegetation, 0.0054 gram. Lead equals 0.0021 per cent, or 21 parts per million by weight. This is equivalent to 0.9 gram per 100 pounds of grass.

Arsenic.—Weight of arsenic in 5 grams, 0.000025 gram. Arsenic equals 0.0005 per cent or 5 parts per million by weight. This is equivalent to 0.2 gram per 100 pounds of grass.

SUMMARY.

A small quantity of lead and arsenic was present in the vegetation taken from the bluffs on the north side of the straits, between Dillon Point and Dos Reis Cove, at the end of the dry season. The amount found (21 parts lead per million and 5 parts arsenic per million of vegetation) represented the maximum deposit for a season. Inasmuch as the Selby smelter is the only known source of lead emanations in the vicinity, it must be concluded that the lead came from the Selby smelter.

DETAILS OF METHOD FOR THE DETERMINATION OF SMALL AMOUNTS OF SULPHUR DIOXIDE IN THE ATMOSPHERE.

NECESSITY OF TAKING "INSTANTANEOUS" SAMPLES AND MAKING RAPID ANALYSES OF SULPHUR DIOXIDE IN THE SAMPLES.

When the atmosphere is contaminated by noxious gases discharged from industrial plants, the amount of these gases present at any point in the vicinity is usually variable, even though the volume of the gases being discharged is a constant quantity over a long period of time. These variations in the concentration of the contaminating gases are due primarily to changes in the direction and velocity of the wind, and are influenced by changes in atmospheric pressure, humidity, and temperature. Not only is the concentration affected by general wind conditions, but local wind currents play an important part. Slight changes in the wind, or in barometric or temperature conditions, may produce very great changes in the concentration of the gases, so that even during a period of several minutes the amount of the gases present may vary between zero and a concentration many times greater than the average. Thus, a knowledge of the average concentration of the gases in the air at any point for a period of days or even hours may not be sufficient to indicate whether the gases were present momentarily to such an extent as to be a nuisance to people or a possible cause for damage to plant life.

In order to make a detailed study of the extent to which the atmosphere in the so-called "smoke zone" of a smelting plant is contaminated by the sulphur dioxide gas emitted from the stacks of the smelter, it is as necessary to determine these variations in the sulphur dioxide content of the air as it is to determine the average content during any period. The determination of the range of these variations necessitates the taking of a great number of samples, the taking of each sample in a brief interval of time, say less than 30 seconds, and sufficiently often to include the maximum and minimum concentration during any period. To carry out this scheme, it is desirable to have a quick and sensitive volumetric method for the analysis

of the samples; otherwise a considerable number of sample containers are necessary.

For the determination of the average sulphur dioxide content of the air during a period of a day or several hours, there are several methods applicable. The methods most commonly used are based on the aspiration of a measured volume of air through absorption bottles, or towers, containing solutions of caustic alkali, alkaline carbonates or bicarbonates, or iodine. The sulphur dioxide is oxidized and dissolved by the solution and subsequently determined as barium sulphate. In determining the average total sulphur content of the air, a method based on this principle has been used by the Selby Smelter Commission.

For several reasons, none of these aspiration methods is applicable for the rapid determination of sulphur dioxide. For the collection of a gravimetrically determinable amount of sulphur dioxide from highly diluted air, it is necessary to aspirate a relatively large sample; an operation that with any feasible field apparatus would require a considerable length of time. The aspiration must be carried out in such a manner that the last traces of sulphur dioxide will be completely removed. This would eliminate the possibility of aspirating above a certain rate. If the atmosphere contains sulphur trioxide or sulphuric acid fume or vapor, these constituents will be included in the samples and, if calculated to sulphur dioxide, will give high results.

ESSENTIAL FEATURES OF METHODS USED BY THE COMMISSION.

In the investigations for the Selby Smelter Commission, the determinations of sulphur dioxide in the atmosphere were made by methods that fulfilled the desired conditions, in that they allowed (1) the taking of a satisfactory sample in less than 15 seconds' time; (2) the rapid volumetric determinations of the sulphur dioxide in the sample, an operation requiring less than 5 minutes; (3) the determination of minute quantities of sulphur dioxide with a reasonable degree of accuracy.

For the primary novel features of these methods, we are indebted to Mr. J. R. Marston, chief chemist at the Selby smelter. These novel features comprise:

1. The method of running a "blank" simultaneously and in the same manner as the "sample" determination; this "blank" being run on an equal volume of air which, previous to a test, had been treated with an oxidizing agent to oxidize any reducing constituents that might be present.

2. The method of titrating the sulphur dioxide in the sample with iodine in a starch solution and obtaining the end point of the reaction by comparing the colors of the "sample" and "blank" solutions;

the iodine required to give to the "sample" solution the same color as the "blank" being the equivalent of the sulphur dioxide in the sample.

During the first few weeks of these investigations, the method used was similar in detail to the original method of Mr. Marston. Due to the fact that in this method there are present certain sources of error, though these errors were found to be of slight importance as affecting the results obtained by analyses of air in the Selby smoke zone, it was thought desirable to devise a modification of this method which would eliminate them.

A description of Marston's method as adopted for work of the Selby Smelter Commission is given below. This is followed by a discussion of the investigations made to determine the accuracy of the method, both in regard to the completeness of the chemical reaction involved, and in regard to manipulative details. A detailed description is then given of the method, modified in mechanical details as finally adopted to correct certain sources of error inherent in the original method. This is followed by a brief description of an official test of this adopted method made by several interested chemists.

Each method is dependent on the reaction between iodine and sulphur dioxide in aqueous solution as represented by the equation

$$I_2+SO_2+2H_2O=2HI+H_2SO_4$$
$$255 \text{ grams } I_2=64 \text{ grams } SO_2.$$

Thus, 1 c. c. N/500 iodine solution is equivalent to 0.000064 gram SO_2, equal to 0.0224 c. c. SO_2 at 0° C. and 760 mm.

DESCRIPTION OF MARSTON'S METHOD, ADAPTED TO WORK OF THE COMMISSION.

APPARATUS REQUIRED.

Sample bottles.—Two 24-liter aspirator bottles were used for containers. The bottles were made of the same kind of white glass. They were equipped with rubber stoppers at the top and bottom tubulures.

Test bottles.—Two 500-c. c. glass-stoppered specimen jars of uniformly clear white glass were used as "test" bottles. On the outside of each bottle, covering the lower half, except over a vertical strip 5 to 7 cm. wide, was pasted a uniformly white paper as a background for color comparisons.

SOLUTIONS REQUIRED.

The solutions required are as follows:

Iodine solution, containing 0.255 gram iodine per liter=N/500 iodine.

Starch solution, containing 1 gram starch per liter.

The starch solution is best prepared by making a paste of the starch in cold water, adding it to the boiling water, and continuing the boiling for five minutes.

The solution is kept in tightly stoppered bottles protected from sunlight. Starch solution one day old was the most sensitive to color changes. The addition of potassium iodide, about 2 grams per liter, served to make the end point more sensitive.

PROCEDURE.

Preliminary operation.—To one aspirator is added 250 c. c. of the starch solution containing a slight excess of iodine. The aspirator is then stoppered and shaken vigorously for about two minutes, more iodine being added, and the aspirator reshaken if the blue color of the starch solution is discharged. This oxidizing solution is then poured to waste and the aspirator tightly stoppered. Being thus freed from sulphur dioxide or other possible iodine reducing gases, this aspirator is used as a "blank" when making the determination of a "sample."

Sampling.—The second aspirator is then filled with clear water to which has been added a few drops of a strong starch solution and sufficient iodine to bring the water to a faint blue color. This was found to be necessary as all water, distilled or tap water, has been found to have a variable iodine reducing factor. To take the sample the aspirator is emptied of the water through the lower tubulure, the air simultaneously entering through the top tubulure. During this operation care is taken not to let the surface of the water become agitated. The aspirator is completely emptied of its water content in about 15 seconds, and then, when completely filled with the air sample, is stoppered.

DETERMINATION.

To about 500 c. c. of the starch solution is added sufficient iodine to bring the solution to a desired blue color. This solution is then divided equally between the two test bottles. The solution from one test bottle is poured into the aspirator containing the sample, and from the other into the blank aspirator. Then, under the same conditions as to sunlight and temperature, the two aspirators are shaken vigorously in such a manner as to wet completely the inner surfaces and to bring the sampled air in contact with the starch iodide solution. In case the color of the sample solution is completely discharged during this operation, more iodine is added and the solution again shaken. The solutions are then transferred to the test bottles and their colors compared, sufficient standard iodine being added by burette to the sample solution to give it the same color intensity as that of the blank. From the total iodine required to bring the colors into coincidence is then calculated the amount of sulphur dioxide in the sample.

Using a good, clear, starch solution, an analyst with a little experience may easily detect a difference in color due to the addition of 0.1 c. c. of a N/500 iodine solution to 250 c. c. of the starch solution. As 0.1 c. c. N/500 iodine is equivalent to 0.0022 c. c. sulphur dioxide (at 0° and 760 mm.), simple calculation shows that less than 0.1 part sulphur dioxide in 1,000,000 parts of air by volume may be determined, using a 24-liter sample aspirator.

When a series of samples is begun and carried through to completion in a short period of time, it has been found necessary to give the blank a preliminary oxidation only at the start. However, if the blank is allowed to stand for an hour or more, especially on a warm, sunny day, experience has shown it to be necessary to prepare the blank afresh before starting a test.

INVESTIGATIONS TO DETERMINE ACCURACY OF METHOD.

The method described above was subjected to a very careful investigation to determine its accuracy and limitations under different conditions. This work was done in December, 1913, by Mr. G. N. Libby and Mr. R. J. McKay, under the direction of the writer at the Bureau of Mines laboratory in San Francisco.

In order to realize, in the laboratory, the conditions that exist in the field, where the preparing of blank aspirators, transferring of solutions, and analytical manipulations are done in an atmosphere containing sulphur dioxide, it was found necessary to devise some scheme for supplying air of known sulphur dioxide content.

APPARATUS FOR PRODUCING AND MAINTAINING A KNOWN MIXTURE OF SULPHUR DIOXIDE AND AIR.

By means of this apparatus a measured current of sulphur dioxide was continuously supplied to a known current of air drawn into a fan, where the two were thoroughly mixed and discharged into a room or booth, thus giving a known concentration of sulphur dioxide.

Figure 6 shows an arrangement for measuring the rate of flow of sulphur dioxide gas from a tank of liquid sulphur dioxide. (See also Pl. XII, *B*.)

The construction and use of the meter [a] is dependent upon the principle that the difference in pressure between the two ends of a capillary tube through which a stream of gas is flowing is a measure of the rate of flow of the gas.

In figure 6 *d* represents a tank of liquid sulphur dioxide under pressure. The rate of flow of gas from the tank is regulated by the valve at the top of the tank. The gas is conducted by glass connection to

[a] For the suggestion of the use of this type of meter, we are indebted to Dr. L. H. Duschak of the Bureau of Mines.

the capillary *a-a'*, which is joined by T-tube connections to the manometer. The difference in pressure between the two ends of the capillary is shown by the difference in level of the menisci *e* and *f*, which is measured on the meter stick *b*.

Before proceeding to any test, it was necessary to "calibrate" the capillary; that is, to determine the pressure differences or manometer readings for different rates of flow. This was accomplished by allowing the gas to flow through the capillary for a definite period of time, and with a constant pressure difference, into a solution con-

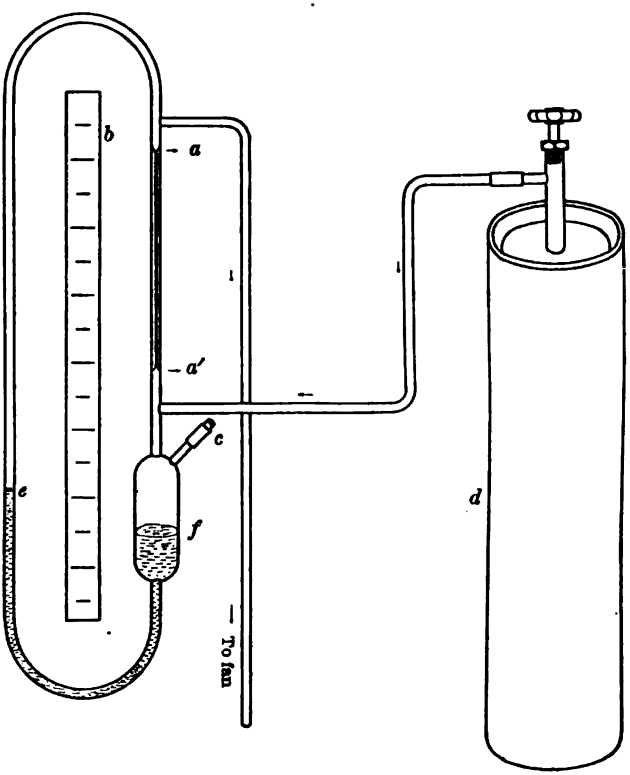

FIGURE 6.—Meter for measuring rate of flow of sulphur dioxide.

taining a known volume of standard caustic alkali or standard iodine, and determining by volumetric methods the sulphur dioxide delivered. The volume of sulphur dioxide delivered corresponding to four or five different pressure differences was determined for each capillary used. In plotting the pressure differences, or manometer readings, as abscissae, and the corresponding rates of flow, in cubic centimeters per minute, as ordinates, the curve for each capillary was obtained, which, for the range of volumes delivered in our tests, was practically a straight line.

After leaving the capillary the sulphur dioxide was conducted by glass tubing to the intake of a direct motor-driven forge blower. The air and sulphur dioxide mixture was then discharged into a mixing box of No. 18 galvanized iron, 36 inches long and 12 inches in diameter, containing 11 baffles. These baffles were 5 inches high and 3 inches apart, and were staggered so that the mixture had to zigzag through them. After passing through the baffle box, the mixture was conducted through a galvanized-iron pipe 48 inches long and 3¾ inches inside diameter, then through a galvanized-iron box 12 inches square by 18 inches long, from which the gases were discharged into the booth.

The booth, 6 feet long, 4 feet wide, and 6 feet high, was framed with wood and covered with a close-mesh duck cloth. At one end of the hood was a curtain flap, serving as an entrance. As the volume of air discharged into the hood by the fan was about 110 cubic feet per minute, there was maintained an excess pressure inside the booth, which prevented pure air from diffusing inward to dilute the mixture.

Six inches back from the discharge end of the 3¾-inch pipe Pitot tubes were inserted for the determination of the velocity, and thus the volume of the mixture being discharged. The Pitot tubes were of the type shown in figure 7 and were constructed in the Bureau of Mines laboratory.

The manometer used was the U-tube type, placed on a slope of 1 in 10, which allowed a considerable movement of the manometer liquid (alcohol) for a small velocity head. These Pitot tubes had been checked against a Pacific Gas & Electric 80-light gas meter, the measurements being made in a pipe 1.04 inches in diameter. Records of the Bureau of Mines show that for velocities up to 1,800 feet per minute, by applying a factor of 0.95, the velocities calculated from the Pitot tube readings were within 2 per cent of the actual velocities as calculated from the volume measured by the gas meter. From considerable experience with this and other types of Pitot tubes the writer was prepared to apply the factor 0.95 to the calculated results and feel certain that the results so obtained were within 2 per cent of the actual, and as the records of the Bureau of Mines checked up this factor, the Pitot tubes were not again tested.

The cross section of the pipe was explored carefully by these tubes under a wide range of velocities. With velocities ranging between 1,200 and 1,800 feet per minute the velocity in the center of the pipe was found to be 1.05 times the average velocity.

Through the baffle box and pipe, the fan discharged an average of 112 cubic feet or 3,200,000 c. c. of air per minute. In order to get a mixture of 1 part SO_2 per million parts of air, it was necessary to add 3.2 c. c. of SO_2 per minute, which could be measured with an accuracy of at least 5 per cent. Thus, with a mixture of 1 part in 1,000,000, we were sure that the liability of error was not greater

than 10 per cent at the most. As the concentration was increased to above 3 to 4 parts per million, the possible percentage of error in metering the sulphur dioxide became less, and the mixtures were undoubtedly within 5 per cent of the calculated.

From the preceding discussion it is evident that, allowing several minutes to elapse after starting to blow the mixture into the booth,

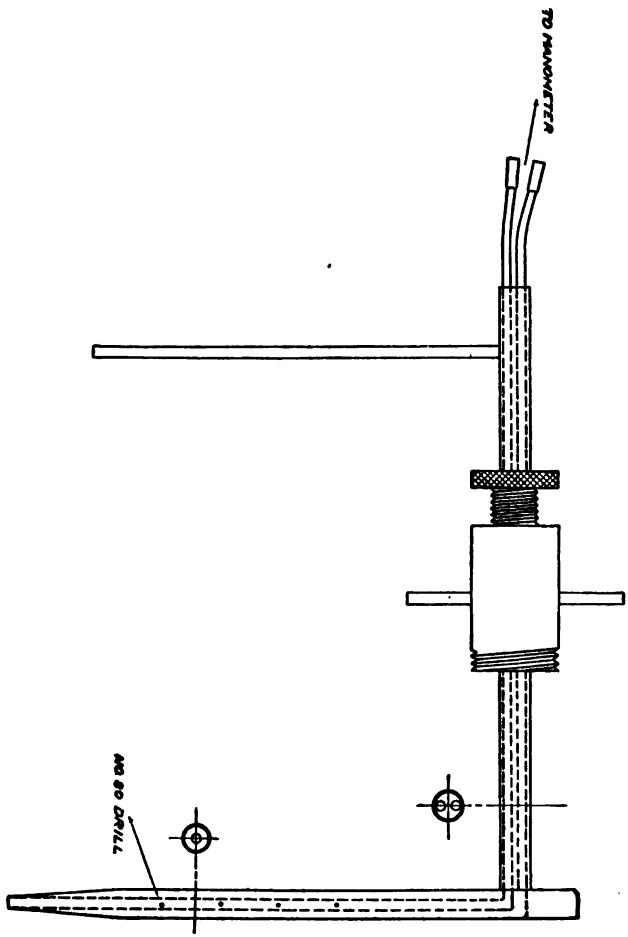

FIGURE 7.—Arrangement of Pitot tubes used in sulphur dioxide determinations.

the concentration of the sulphur dioxide in the air of the booth would be within 10 per cent of the calculated concentration for the most dilute mixture (1 to 5 parts per million) and within 5 per cent for stronger mixtures.

RESULTS OF TESTS TO DETERMINE ACCURACY OF MARSTON METHOD.

In order to test the accuracy of the method of analysis, it was necessary only to carry out the method in the booth in the same manner

as in the field. Tests were made with concentrations up to 14 parts SO_2 per million parts of air, with results as shown in the following table.

Results of tests to check Marston method of determination of sulphur dioxide in air.

Calculated mixture.			Volume of sample at 0° and 76 c. m.	N/500 I_2 used.	SO_2 equivalent to I_2 used.	Parts of SO_2 per million parts of air.	Actual SO_2 content divided by calculated content.
Air.	SO_2.	Parts of SO_2 per million parts of air.					
Liters.	*C. c.*		*Liters.*	*C. c.*	*C. c.*		*Per cent.*
3,000	1.6	0.5	22.2	0.6	0.0134	0.6	120
3,000	2.5	.8	22.2	.9	.0202	.9	112
3,000	3.2	1.1	22.2	1.1	.0246	1.1	100
3,000	4.3	1.4	22.2	1.5	.0336	1.5	107
3,000	4.3	1.4	12.4	.7	.0156	1.3	93
3,000	6.8	2.3	22.2	2.0	.0448	2.0	87
3,000	6.8	2.3	12.4	1.1	.0246	2.0	87
3,000	9.4	3.1	22.4	2.7	.0602	2.7	87
3,000	10.2	3.4	12.4	1.7	.0381	3.1	91
3,000	18.0	6.0	22.4	4.7	.1053	4.7	78
3,000	18.4	6.1	12.4	2.8	.0627	5.0	82
3,000	24.0	8.0	12.4	3.4	.0762	6.1	76
3,000	13.3	4.4	22.2	3.3	.0739	3.3	75
2,500	35.0	14.0	12.2	5.6	.1256	10.3	74

A brief study of this table shows that when working with concentrations of less than 3 parts per million the method gave results that checked up the calculated mixtures to within approximately 10 per cent. As the concentrations were increased above 3 parts per million, however, the determination was found to be always lower than the calculated mixture, the difference being approximately 20 per cent with a calculated mixture of 5 to 6 parts per million, and 25 per cent with higher concentrations.

INVESTIGATIONS TO DETERMINE CAUSE OF LOW RESULTS OBTAINED BY MARSTON METHOD.

Due to the fact that in this method the chemical reactions involved take place in a very dilute solution of the reacting agents, the question arose as to whether or not the reaction is quantitative at that great dilution. There was also a question concerning the possibility of a partial oxidation of the sulphur dioxide by the oxygen dissolved in the starch solution giving a low iodine titration. Inasmuch as the titrations checked the calculated mixtures more closely on the smaller concentrations of sulphur dioxide, this possibility did not seem reasonable. Nevertheless, it was decided to investigate the question carefully.

Ten c. c. of SO_2 at 16° C. was measured in a burette over mercury. The gas was diluted with air at 16° C. to 100 c. c. Twenty c. c. of this mixture was again diluted to 100 c. c. with sulphur dioxide free air. The second mixture was again diluted 25 to 100 c. c. so that

the resulting mixture contained 0.5 per cent SO_2 by volume, or 1 c. c. at 16° C., equal to 0.0000135 gram of SO_2.

Two aspirators were given a preliminary oxidizing wash with a slightly colored starch iodide solution, as previously described. To each aspirator was then added starch solution containing a slight excess of iodine. A glass stopcock having been inserted through the top rubber stopper, one aspirator was slightly evacuated. A measured volume of the mixture of sulphur dioxide and air from the burette was added to the aspirator, and after the air necessary to fill the partial vacuum had been admitted, the stopcock was closed. The aspirators were then shaken as in the regular analytical method about 60 times, then the theoretically required volume of N/500 iodine was added to the aspirator containing the sulphur dioxide, and the aspirators were shaken again. The starch solutions were then removed to the test bottles and iodine added to either the determination or the blank to bring the solutions to the same color. Results are given in the following table:

Results of tests to determine quantitative accuracy of reaction at high dilution, using gas and air mixtures.

Quantity of 0.5 per cent SO_2 mixture used at 17° C.	Parts of SO_2 per million parts of air in aspirator.	Quantity of SO_2 added.	N/500 I_2 used.	SO_2 equivalent to I_2 used.	Proportion recovered by titration.
C. c.		*Grams.*	*C. c.*	*Grams.*	*Per cent.*
2	0.42	0.000027	0.5	0.000032	118
3	.63	.000040	.6	.000038	95
5	1.04	.000068	1.0	.000064	94
8	1.67	.000108	1.7	.000109	101
10	2.10	.000135	2.2	.000141	104
15	3.13	.000202	3.5	.000224	111
20	4.17	.000270	4.1	.000262	97
40	8.34	.000540	8.9	.000570	105
60	12.50	.000810	12.5	.000800	99
.....	.....	.....	.....	.....	[a] 103

[a] Average.

As a second method of determining the quantitative accuracy of the reaction between sulphur dioxide and iodine in dilute solutions, the following tests were made:

An N/100 solution of sulphur dioxide was prepared by absorbing 120 c. c. of pure SO_2 at 18° C. and 760 m. m. in 1,000 c. c. of water. The normality of the solution was checked by titrating against a standard solution of KOH, using phenolphtalein as an indicator. Twenty c. c. of this solution was then diluted to 100 c. c. Thus 1 c. c. solution equaled 0.000064 gram of SO_2. This solution was kept in a tightly stoppered burette away from the sunlight and was used immediately. The solution was added in amounts as shown in the following table, to a 24-liter aspirator that had been given an oxidizing

wash as usual. Two hundred and fifty c. c., or one-half of a starch solution, faintly colored by a slight excess of iodine, was added and the aspirator shaken 60 times. Then the volume of iodine calculated for the sulphur dioxide in the aspirator was added and the aspirator again shaken. The solution was then transferred to a test bottle for titration to bring the color to coincide with that of the other half of the starch solution, which had been shaken in a similar manner in the blank aspirator. These data follow:

Results of tests to determine quantitative accuracy of reaction at high dilution, using sulphur dioxide solutions.

Quantity of N/500 SO_2 added.	Quantity of SO_2 in aspirator.	Quantity of N/500 I_2 used.	Equivalent SO_2.	Proportion recovered by titration.
C. c.	*Grams.*		*Grams.*	*Per cent.*
0.1	0.0000064	0.1	0.0000064	100
.3	.0000192	.3	.0000192	100
.6	.0000384	.6	.0000384	100
1.0	.0000640	.9	.0000576	90
2.0	.0001280	2.1	.0001340	104
3.0	.0001920	2.9	.000186	97
5.0	.000320	5.0	.000320	100
10.0	.000640	9.8	.000626	98
50.0	.003200	49.6	.003180	99

From the results of these tests it is concluded that the reaction $SO_2+I_2+2H_2O=2HI+H_2SO_4$ is quantitative at the dilutions used in this method.

In connection with these tests, however, it was found incidentally that if the titration was made with iodine to the initial appearance of the blue the results were more variable and averaged slightly lower than if obtained by color comparison with a blank. It was also found that if a considerable excess of iodine was used and a titration was made back to the disappearance of the blue using a sulphur dioxide solution, the results were also variable and generally high.

After we had determined that the fundamental chemical reaction involved takes place quantitatively and that the method of titration gives consistently accurate results, it remained for us to determine where errors were introduced mechanically by manipulation details.

MECHANICAL SOURCES OF ERROR.

Without going into any detailed account of the tests to determine these errors, a summary of the conclusions is given below:

1. When samples of air are taken over water, even though the surface of the water is quiet and the aspirator is emptied in less than 20 seconds, there is an appreciable absorption of the sulphur dioxide from the air sample as it comes in contact with the surface of the water which is being displaced. With concentrations of less than 2.5 to 3 parts per million, the amount so absorbed is hardly determinable.

With greater concentrations, however, the sulphur dioxide so dissolved is appreciable and seriously decreases the accuracy of the results.

2. During the process of transferring, by pouring the starch solution into or out of the "blank" aspirator, surrounded by an atmosphere containing sulphur dioxide, there is an appreciable dispersion of the outside air into the blank aspirator. The result of this dispersion is to lower the amount of sulphur dioxide apparent in the sample by an amount equal to the sulphur dioxide carried into the blank.

Likewise, if the sample aspirator is opened to receive the starch solution in an atmosphere containing a greater or less concentration of sulphuric dioxide than present in the aspirator, the dispersion during that time introduces errors for which no correction can be applied.

EXAMPLE.

A 24-liter aspirator was opened for definite periods of time in a booth containing 5 parts SO_2 per million parts of air. The sulphur dioxide diffused into the aspirator was then determined by carrying out the regular procedure in a room containing no sulphur dioxide.

Results of experiment to determine sources of error.

Time aspirator was opened in booth.	N/500 iodine required.	Equivalent parts of SO_2 per million.
Seconds.	*C. c.*	
0	0.0	0.00
5	.2	.18
10	.4	.35
20	.5	.45

3. There was also the direct solution of sulphur dioxide of the surrounding atmosphere in the starch solution during the process of pouring the solution into or out of the aspirators. Of course, the extent to which this direct absorption takes place should be the same in the blank as in the sample solutions, and by carrying out the process under the same conditions there should be no appreciable error introduced. However, a possible element of error must be recognized therein, especially with high concentrations.

4. The action of the iodine in the starch solutions upon the rubber stoppers was found to be appreciable even after washing the stoppers thoroughly with stronger iodine solutions. From this fact it was evident that unless the blank and sample aspirators were treated in about the same manner in regard to allowing the solutions to come in contact with the rubber stoppers, a source of error was introduced.

5. The moistened surfaces of the rubber or glass stoppers were exposed to the air containing 4 or 5 parts SO_2 per million for 15 or 20

seconds. There was found to be an appreciable absorption of sulphur dioxide on the surfaces, which would be a possible slight source of error.

6. Having allowed the blank aspirator to stand a half hour or so, after a determination has been made, it is essential to reoxidize the atmosphere and glass surfaces of the aspirator before using it again as a blank. Occasionally, especially during hot sunny conditions, there is a distinct iodine titration of the blank at the end of a half hour.

7. The necessity of using a blank solution and of treating that solution in a blank aspirator in a manner similar to the sample was made apparent. No constant factor for correction could be applied for the color change in the iodine solution was influenced by the light, temperature, and length of time that the solution was contained in the aspirator.

8. As a result of these tests, it was concluded that in the mechanical manipulation of this method, especially in the manner of taking samples and of transferring the starch solution to and out of the aspirator bottles, there are sources of error which account for the low results obtained when analyzing samples containing more than 3 or 4 parts of sulphur dioxide per million.

GENERAL CONCLUSIONS.

In determining the sulphur dioxide in air containing less than 3 or 4 parts sulphur dioxide per million parts of air the method is sufficiently accurate for all practical purposes. With higher concentrations, however, it is desirable to use a method whereby the sources of error, introduced mechanically by this method, are eliminated.

In order to eliminate the sources of error found to be present in the first method of analysis, the following method was devised, carefully tested out, and was subsequently used in field work for the commission during March, April, and May of 1914.

As this method is probably the most accurate and sensitive of any that has been used for the determination of small amounts of sulphur dioxide in the air it will be described here in considerable detail.

DESCRIPTION OF SELBY SMELTER COMMISSION METHOD FOR DETERMINING SULPHUR DIOXIDE IN AIR.

APPARATUS.

Sample bottles.—Two 24-liter aspirator bottles are used for sample containers (figs. 8 and 9). The bottles are of the same kind of glass, so that the action of heat and light on the iodine will be the same in each. The top tubulure of each aspirator is closed by a rubber stopper through which a glass stopcock, *a*, is inserted. In the lower

tubulure is placed a one-hole rubber stopper, *b*, in which is fitted a glass plug extending for about 1½ inches outside the stopper.

Test bottles.—Two test bottles are used, each a 500-c. c. wide-mouth specimen jar, of uniformly clear white glass. (See figs. 8 and 9.) Each bottle is equipped with a three-hole rubber stopper. Through one opening of the stopper is inserted a glass tube of about 4-mm. diameter, bent at right angles (tube *c*, fig. 8).

Through the second opening is inserted a tube, *d*, of about 2-mm. bore, extending nearly to the bottom of the bottle and closed on the outside by the cap *e*. In the third hole is inserted a glass tube, *f*. On the outside of the bottles, covering the lower half, except over a vertical strip 5 to 7 cm. wide, is pasted a uniformly white paper to serve as a background for color comparison.

Mixing bottle.—A 1,000-c. c. wide-mouth specimen jar is equipped with a three-holed rubber stopper. In one hole a 4-mm. bore tube is inserted reaching to the bottom. In the other two holes are inserted glass rods as stoppers.

Burette.—For the purpose of discharging the iodine solution well inside the test bottles when titrating, the burette is equipped with a long small-bore delivery tube.

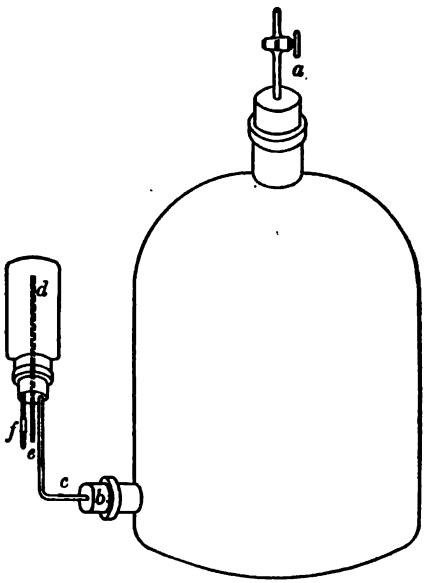

FIGURE 8.—Sample bottle and test bottle arranged for transferring solution from test bottle into sample bottle.

Vacuum pump.—For evacuating the sample bottle, we used a cylindrical hand pump, or a large wheel-operated pump that had been obtained primarily for use in connection with total-sulphur determinations and which will be described later. The vacuum gage is a calibrated mercury column.

SOLUTIONS REQUIRED.

Iodine solution.—0.255 gram iodine per liter = N/500 normal.

1 c. c. N/500 solution = 0.000064 gram SO_2 = 0.0224 c. c. SO_2 at 0° C. and 760 mm.

Starch solution.—Either soluble starch or grain starch may be used for making the starch solutions. With either, about 1 gram of starch per liter of water gives the most satisfactory solution. It is best prepared by adding the starch in paste form to boiling water, boiling for

several minutes, then cooling slowly. The addition of potassium iodide, 2 grams per liter, was found to render the color comparison more sensitive.

PRELIMINARY PROCEDURE.

About 500 c. c. of the starch solution is brought to a desired light-blue color with iodine in the mixing bottle. One-half of this starch iodide solution is then transferred to each test bottle. To make the transfer so that the solution will not come in contact with the air, the tube *c* (fig. 8) of the test bottle is inserted in one of the holes of the stopper of the mixing bottle. The tube *f* (fig. 8) of the test bottle is opened. The mixing bottle is inverted and the solution run into the test bottle through *c* (fig. 8).

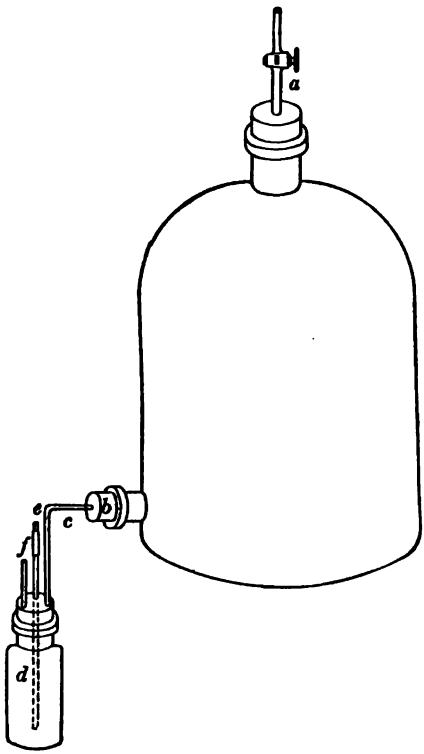

FIGURE 9.—Sample bottle and test bottle arranged for transferring solution from sample bottle to test bottle.

Having transferred the solution to the test bottles, the colors of the solutions in the test bottles are compared carefully to make sure that they are coincident, and that no dirt or film on the glass obscures the colors.

The solutions are then transferred to the aspirators. This is accomplished, with the test bottle and the sample bottle arranged as shown in figure 8, by inserting the tube *c* (fig. 8) of the test bottle into the hole of stopper *b* of aspirator, removing the cap *e* from tube *d*, inverting the test bottle and opening the glass stopcock *a* of the aspirator. The solution having been transferred, the glass stopper is replaced in *b*, and *a* closed. The aspirators are shaken vigorously for about five minutes to wash them and to oxidize any reducing gases that might be present in the aspirator. The solutions are then transferred back to the test bottles through the tube *c*, by holding the test bottles under the aspirators, opening the glass stopcock *a* of the aspirators and the glass tube *f* of the test bottles (see fig. 9).

Having transferred the solutions back to the test bottles, the colors of the solutions are then compared. If the two solutions have the same color, the aspirators are considered ready for analytical

work. If the colors are not the same, the starch solutions are again mixed, transferred to the test bottles and to the aspirators as before. The aspirators are again shaken, the whole operation being repeated until after removal from aspirators, the solutions are of the same color, or can be brought to the same color by the addition of not more than 0.1 c. c. N/500 iodine to the lighter one.

SAMPLING.

Having washed the aspirators sufficiently so that their iodine consumption factors are zero, or a constant for both, a fresh starch iodide solution is divided between the two aspirators as before, 250 c. c. to each. One aspirator is then evacuated by pump to a 380-mm. vacuum. Both aspirators are then carried to the point where the sample is to be taken, care being taken that both aspirators have the same exposure to sunlight. The sample is taken by opening the stopcock *a* (fig. 9) of the evacuated aspirator, the volume taken in being that required to bring the pressure in the aspirator back to atmospheric conditions.

DETERMINATION.

The two aspirators are then shaken vigorously 60 to 80 times in such a manner that the sample and solution are brought into intimate contact, the "blank" being shaken in the same manner as the determination. The starch solutions are then transferred to the test bottles in the manner previously described. The colors of the solutions are then compared, and by means of the burette sufficient N/500 iodine solution is added through the hole *f* (fig. 9) in the "determination" bottle to bring the color to that of the "blank." In cases where the color of the determination solution is very much lighter than the blank, or is completely discharged, this solution is titrated to a color slightly deeper than that of the blank, the two solutions are returned to their respective aspirators, the aspirators are again shaken and the colors compared as before. Following this procedure, it is evident that, provided the determinations are made not more than 30 minutes apart, each determination prepares the aspirators for the following determination, thereby eliminating the necessity of going through the preliminary oxidation process each time.

As stated previously, in discussing the first method, with a little experience and using a well-prepared starch solution an analyst can detect, by comparison, a change produced by the addition of 0.1 c. c. of N/500 iodine to 250 c. c. of the starch solution.

EXAMPLE.

Temperature of air, 16° C.
Barometric pressure, 760 mm.
Capacity of aspirator, 24.2 liters.
Extent of evacuation, 380 mm.
Volume, $24 \times \frac{380}{760} \times \frac{273}{289} = 11.3$ liters at 0° C. and 760 mm.

Titration, 0.1 c. c. N/1000 iodine=0.1×0.0224=0.00224 c. c. SO_2 at 0° C. and 760 mm.

$$SO_2=\frac{.00224}{11,300}$$
$$=0.00002 \text{ per cent.}$$
$$=0.2 \text{ part per million, by volume.}$$

SPECIAL NOTES.

In the course of working out the details of manipulation for this method it was found to be much more satisfactory to introduce the starch solution into the aspirators before evacuating than to introduce it later after the sample was contained in the aspirator. With the starch solution present in the aspirators when the sample was being taken the aspirator could be shaken immediately, which eliminated any possibility of the disappearance of sulphur dioxide by oxidation or adsorption in contact with the alkaline surface of the glass. There was no appreciable loss of iodine from the starch-iodine solution during evacuation.

One of our field-apparatus sets, the automobile laboratory, was equipped with 12 to 14 liter aspirators. For the purpose of getting the full 12 to 14 liter capacity as a sample we tried the method of connecting the aspirator with the pump and drawing through a large volume of air; for example, 50 or 60 liters, taking the last 12 liters as a sample. Not only did this method take considerable time, but it introduced very grave errors. Unless the aspirator was absolutely dry, requiring a treatment of alcohol and ether, there was a surprisingly large and variable adsorption of the sulphur dioxide from the first 40 or 50 liters that passed through the aspirator, the amount adsorbed being different for different degrees of dryness of the aspirator. When aspirators that had been allowed to drain only for several minutes were used, the adsorption was great, and was due undoubtedly to reaction with alkali or solution in water, or both. Thus, as it was not possible to dry the aspirators satisfactorily in the field, this method of taking a sample was not considered desirable.

However, it was found that with a 12 to 14 liter aspirator 150 c. c. of starch solution was sufficient for washing the sulphur dioxide from the sample. With this smaller sample 0.1 c. c. of an N/1000 iodine solution gives a satisfactory color change, and the degree of accuracy in titration was thereby as great as with the large samples.

The details of the many tests made to determine the accuracy of this method need not be given here. They established that the method is accurate with all concentrations liable to be encountered in any contaminated atmosphere. The method is rapid and the manipulation is not difficult.

OFFICIAL TEST OF MODIFIED METHOD.

On May 20, 1914, an official test of the method was carried out in the laboratory of the Bureau of Mines in the presence of the following chemists: Ralph A. Gould and E. C. Franklin, of the Selby Smelter Commission; A. E. Wells and R. J. McKay, of the commission staff; L. H. Duschak and G. C. Bartells, jr., of the Bureau of Mines; J. R. Marston, of the American Smelting & Refining Co., Selby plant; and E. P. Fleming, of the American Smelting & Refining Co., Utah department.

A brief summary of this test will be given here.

An N/100 iodine solution was prepared and standardized by titration with N/100 sodium thiosulphate solution (2.48 grams of $Na_2S_2O_3.5H_2O$ per liter). Fifty c. c. of this standardized N/100 solution was diluted to 250 c. c., giving an N/500 solution.

A sulphur dioxide mixture was prepared in a burette over mercury by successively diluting the pure SO_2 gas with air, the resulting gas containing 0.1 per cent SO_2 by volume.

10 c. c. SO_2 diluted to 100 c. c. = 10 per cent SO_2 mixture (1).
10 c. c. of mixture 1 diluted to 100 = 1 per cent SO_2 mixture (2).
10 c. c. of mixture 2 diluted to 100 = 0.1 per cent SO_2 mixture (3).

The aspirators and test bottles used were a set sent to the laboratory from a field station and had been thoroughly cleaned and washed. The aspirators were then oxidized with a starch-iodine solution containing a slight excess of iodine until upon removal from the aspirators the solutions exactly corresponded in color. The determinations were made in the usual manner by adding the starch solutions to the aspirators, slightly evacuating one aspirator, adding a definite volume of the known mixture, and determining in the regular manner the sulphur dioxide so added.

Results of determinations.

Volume of mixture added.	Mixture used.[a]	Volume of SO_2 at 0° C. and 760 mm.	Quantity of N/500 I_2 used.	Quantity of SO_2 equivalent to I_2 at 0° C. and 760 mm.	Proportion of SO_2 recovered.
C. c.		*C. c.*	*C. c.*	*C. c*	*Per cent.*
45.6	2	0.452	18.9	0.423	98
38.6	3	.366	1.7	.381	104
20.0	3	.019	.8	.018	95

[a] See above.

The following tests of the method were made, using mixtures in a booth prepared by the fan-and-meter apparatus previously described.

Results of tests.

Calculated volume of SO_2 in hood.	Volume of sample at 0° C. and 760 mm.	Net quantity of N/500 I_2 used.	Volume of SO_2 as determined by analysis.	Proportion of calculated amount.
C. c.	*C. c.*	*C. c.*	*C. c.*	*Per cent.*
3.2	11.4	1.9	3.7	116
3.2	11.4	1.9	3.7	115
(a)	11.4	.1	.2	.....
.7	11.4	.4	.8	115
5.0	11.4	2.4	4.7	94
13.8	11.4	7.25	14.5	105

a Air from window.

At the time of the above tests an experiment was made to illustrate the danger of obtaining erroneous results by drawing through the sample aspirator a volume of air much greater than the final sample. A 2.5-liter aspirator was washed and drained. Through this was drawn in five minutes 12 liters of air containing 6 parts sulphur dioxide per million parts of air. The final 2.5 liters was taken as a sample and analyzed in the usual manner by titrating with iodine in starch and comparing colors with a "blank." The sulphur dioxide recovered by analysis corresponds to 19.8 parts sulphur dioxide per million, whereas the mixture contained only 6 parts per million.

FIELD NOTES.

When using this method for analyses of the air in the "smoke zone" of a smelter, the following notes should be recorded:

1. Time.
2. Temperature of air.
3. Barometric pressure.
4. Direction of wind.
5. Approximate velocity of wind.
6. Capacity of aspirator used.
7. Initial vacuum in aspirator.
8. Iodine titration, c. c. N/500 solution.

From the above is calculated:

1. Volume of sample at 0° C. and 760 cm.
2. Volume of sulphur dioxide equivalent to iodine.
3. Ratio of sulphur dioxide to air, parts per million.

METHOD FOR THE DETERMINATION OF THE TOTAL SULPHUR IN THE ATMOSPHERE PRESENT AS DIOXIDE OR TRIOXIDE.

For the determination of total sulphur present in the air, either as dioxide or trioxide, or the average sulphur dioxide present in the air during a considerable period of time, the following method was used.

METHOD.

A measured volume of air was aspirated through a suitable absorption apparatus containing solutions in which the sulphur dioxide was oxidized and dissolved and in which the trioxide, either in the form of vapor or fume, was also absorbed. The sulphur so collected was then determined gravimetrically as barium sulphate.

APPARATUS.

The absorption apparatus (fig. 10) consisted of a train of three glass tubes, 4.5 cm. inside diameter, and 110 cm. long, about four-fifths of each tube being filled with glass beads. Over the top of each tube was fitted a glass cap, *k*, the joint being made tight by a thin rubber gasket. Through the top of each cap was inserted and sealed a 100-c. c. separating funnel, *c*, and also an outlet tube, *g*, 0.6 cm. inside diameter, bent as shown in the illustration. To the bottom of each tube was welded a glass stopcock, *f*, and an outlet tube, *h*, 0.6 cm. diameter. The outlet tube, *g*, of one tube was connected to the inlet, *h*, of the next following by a glass tube, *d*, of the same diameter, the glass joints, *i*, being made tight, glass to glass, so that the rubber tubing on the outside was not exposed to the action of the gases or fumes from the inside. At a point 5 cm. from the bottom of each tube, the glass was so indented as to provide a seat for a pad of glass wool 2 cm. thick, which held the glass beads in place.

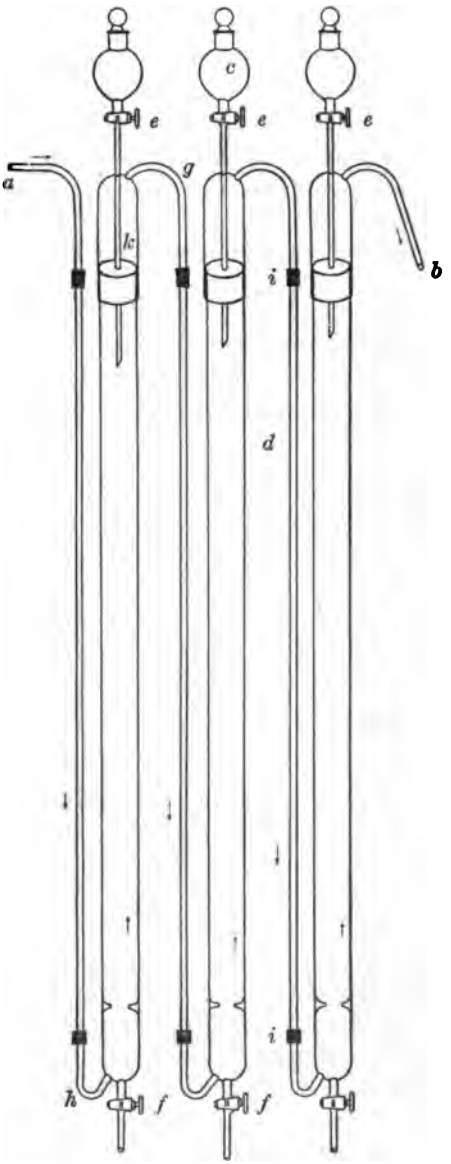

FIGURE 10.—Apparatus for determining total sulphur present in atmosphere as dioxide or trioxide.

In order to maintain a steady flow of air through the absorption train entering at *a* and leaving at *b*, and at the same time to measure the volume accurately, a steel tank of known capacity was evacuated to a known degree, then connected to the absorption train and the air drawn through the train until the pressure in the tank was brought back to a known point. The tank used had a capacity of 116 liters or 4.06 cubic feet. For evacuating the tank there was used a hand-wheel-driven double-cylinder pump superimposed on the tank itself. The pump and tank arrangement was a standard combination beer pump manufactured by the Cleveland Faucet Co., the valves being changed to produce vacuum rather than pressure in the tank. The apparatus is shown in Plate XI, *A*, and Plate XII, *A*.

SAMPLE BOTTLES.

For the sample solution 500-c. c. glass-stoppered tincture bottles that were thoroughly washed to free them from possible contaminating salts were used as containers.

ABSORPTION SOLUTIONS.

In the first tower of the train a strongly oxidizing solution of either bromine or iodine was used. In the two following towers were used either a dilute ammoniacal, or a 0.2 per cent sodium bicarbonate solution. The aspiration of the air through the train carried bromine and iodine vapor over into the second tower, and even to the third, and it was necessary from time to time, during each test, to replenish these oxidizing agents in the first tower. Stock absorption solutions were made up with distilled water.

PRELIMINARY WASHINGS.

Before a series of tests was started, precautions were taken to assure having the apparatus, glass beads, etc., free from any soluble sulphates. This necessitated boiling the glass beads with strong acids, then repeatedly washing with distilled water and then with the stock solution to be used in the tests. The glass tubes and connections were given a warm acid treatment and then washed. Tests were also made to assure that no traces of sulphur could be introduced into the solutions by the action of bromine, iodine, or alkaline solutions coming in contact with any rubber tubing or gaskets. Even weak solutions were found to attack rubber to such an extent as to introduce an error in the determination, and no rubber surfaces were allowed to be exposed to the solutions.

SAMPLING PROCEDURE.

The solutions were introduced to fill the towers to above the top of the glass beads. The tank was evacuated to the desired vacuum, for example, 22 inches (560 mm.), and then caused to draw the sam-

A. TRAIN OF GLASS TUBES FOR ABSORPTION APPARATUS.

B. "CONCENTRATED" OR "KILL-BACK" TYPE OF BLEACH.

A. ABSORPTION APPARATUS.

B. SULPHUR DIOXIDE METER.

C. "MOTTLED" TYPE OF BLEACH.

ple through the towers at the desired rate, that is, about 1,300 c. c. per minute, until the vacuum was reduced to 7 inches (180 mm.). The tank was then evacuated again, an operation requiring from two to five minutes, and the aspiration repeated. At the beginning and end of each tank filling, the following data were recorded:

1. Time.
2. Temperature of air in tank.
3. Vacuum in tank compared with outside atmosphere.
4. Barometric pressure of outside air (aneroid barometer).

The total volume of each sample varied between 150 and 2,800 liters, but averaged about 570 liters, or 20 cubic feet. At the end of each sampling the solutions were drained from the towers through the stopcock *f* (fig. 10) into the tincture bottles. The first two tubes were washed with about 100 c. c. of the stock solution, and the washings added to the samples, which were tightly stoppered, marked, and sent to the laboratory for analysis. A considerable number of samples of stock solution were sent in as "blanks."

ANALYSIS.

The analyses of the samples were made by the usual gravimetric method for SO_3 in solution, care being taken to avoid errors incident to determining small quantities of SO_3.

When ammoniacal solutions were received they were made acid with hydrochloric acid, and then a slight excess of sodium bicarbonate was added. Each solution was evaporated to about 80 c. c., filtered, and washed, the washings increasing the volume to about 100 c.c. This solution was made very slightly acid, litmus paper being used as an indicator, and 2 or 3 c. c. of a 10 per cent barium chloride solution was added to the boiling solution. The solution was boiled for 10 minutes, then allowed to cool and stand for about 20 hours. The precipitate was then filtered through a proper filter, carefully ignited in a small platinum or porcelain crucible, and weighed as barium sulphate. Weights were recorded to the tenth of a milligram. From the gross weight, corrected for the ash of filter paper, was deducted the weight of barium sulphate precipitated with an equal volume of a "blank" solution, and the net weight taken as that due to the sulphur absorbed from the air samples.

ACCURACY OF RESULTS.

As the air was aspirated through columns totaling about 330 cm. (130 inches) in height, and the bubbles of air were well broken up continuously during the travel through the columns of glass beads, the conditions were excellent for the complete absorption of the sulphur dioxide and trioxide. Evidence of the practically complete absorption is found in the following table, showing the relative pro-

portions of sulphur recovered in the tubes, these figures being an average of 106 determinations:

Proportion of weight in first tube	69.4
Proportion of weight in second tube	22.0
Proportion of weight in third tube	8.6

In 71 tests the solutions from the second and third tubes were combined for analysis. In these tests 75 per cent of the total sulphur recovered was found in the first tube. Thus, in 177 tests, the first tube was found to contain over 71 per cent of the total sulphur. These ratios were found to be general throughout all the tests. From these ratios it was concluded that the sulphur found in the solutions represented, within at least 5 per cent, the total sulphur in the air aspirated.

With reasonable care in handling the solutions, there was but small possibility of contaminating the solutions with sulphur from an outside source.

Many determinations on the "blanks" were made, which indicated that the analytical work was accurate to about 0.3 miligram of $BaSO_4$. With a 570-liter sample 0.3 milligram $BaSO_4$ is equivalent to 0.05 part of SO_2 per million parts of air by volume.

AUTOMOBILE LABORATORY USED BY SELBY SMELTER COMMISSION.

Anyone who has ever attempted to determine the concentrations of sulphur dioxide in the atmosphere of the "smoke zone" of a smelter will agree that it is not satisfactory or advisable to try to obtain that data solely by making analyses at one or two fixed stations. If the locations of the stations are carefully chosen, very valuable information may be obtained at them. However, even with the best-located stations there will be many days when the smoke will not be in that vicinity, and, so far as the data desired are concerned, the stations are of little value.

Thus, to obtain the data concerning the smoke conditions over an extended area in a short time and under various atmospheric conditions, the use of an analytical apparatus capable of being moved quickly from one place to another is more expedient than to attempt to gain that information at several fixed stations.

Realizing the advisability of using a portable laboratory, especially as it was desired to obtain analyses of the air in many places outside the "smoke zone" of the Selby smelter, it was decided by the commission to design and equip a set of apparatus for that purpose on an automobile body.

For this purpose there was purchased a rebuilt E. M. F. 30-horsepower machine from which the rear seat had been removed and a

delivery-wagon body substituted. This body was 42 inches wide by 54 inches long. At the front of this body bed, backed up against the driver's seat, was built a wooden cabinet 36 inches long, 14 inches wide, and 42 inches high, divided into two parts. The upper part was 10 inches deep, and subdivided by 1-inch strips into 24 square pockets each large enough to hold tightly a 500-c. c. tincture bottle. Around the strips was wrapped felt cloth to prevent the glasses striking against wood. The top of this section swung up on hinges placed at the back.

Entrance to the lower section was obtained through doors that swung on hinges at the sides and locked at the center. The upper half of this section was equipped to hold ten 2,500-c. c. solution bottles. These bottles were held tightly in wooden brackets cut to fit the circumference of the bottles. These strips were held in grooves along the sides of the section and could be removed. The lower half of this section was equipped similarly to hold three 12 to 14 liter aspirator bottles. At all points where the glass and wood would come in contact the contact points were covered with felt.

This cabinet was elevated about 10 inches above the machine bed, so that the doors of the cabinet would swing clear of the second smaller chest placed in front. This second chest was 12 by 36 inches by 10 inches deep, with a top lid swinging on hinges at the back. This chest was subdivided into many small compartments to hold burettes, glass tubes, rubber stoppers, tubing, and a miscellaneous supply of small articles.

A third cabinet was placed against one end of the larger cabinet, with a door swinging outward. In this cabinet, 40 inches high by 10 inches wide by 6 inches deep, were placed the absorption towers, which were held tightly in place against felt cushions by brass straps wrapped with felt and strips of wood cut to surround the towers.

At the back of the machine was fastened by bolts the combination pump and steel tank used for drawing the air through the absorption towers. The tank could be evacuated by the operator while standing on the ground. To one post supporting the canvas cover of the outfit was attached a mercury manometer for measuring the vacuum produced in the aspirator used for instantaneous sulphur dioxide sampling. An extra nipple and valve were placed in the connection between the pump and tank, which allowed evacuating the aspirators without interfering with the regular aspiration procedure of the tank.

In place of closing the tops of the glass absorption towers with the regular glass caps cork stoppers were used. These were impregnated with paraffin and covered on the outside with sealing wax, making them perfectly air-tight. A 100-c. c. separating funnel and an outlet tube were inserted through the cork stopper. Otherwise the absorption train was the same as that described in the discussion of the

method to determine the total sulphur content of the air. A space on the machine body about 7 by 36 inches was left free to be used as a bench, the operator standing on the ground. The mud guards over the rear wheels also were used as benches at times.

The apparatus was easily prepared for work. Six or seven minutes after arriving at a place the total-sulphur apparatus could be started drawing in a sample, and the analyst could be taking an "instantaneous" sample for sulphur dioxide determination.

Operated by an equally careful and neat analyst, the results obtained by this portable laboratory were as accurate as those obtained by the operators at the fixed stations.

During the seven and one-half months that this laboratory was in use no breakage of glassware, towers, etc., was caused by the jarring or bumping of the machine, which at times was obliged to travel over very rough roads.

By the use of this apparatus analyses of the air were made in San Francisco, Oakland, Berkeley, Richmond, Martinez, and in practically all the territory included in the so-called Selby smelter zone. Plate XIII shows the automobile laboratory.

A. AUTOMOBILE LABORATORY, SIDE VIEW.

B. AUTOMOBILE LABORATORY, REAR VIEW.

FUMIGATION EXPERIMENTS TO DETERMINE THE EFFECT OF HIGHLY DILUTED SULPHUR DIOXIDE ON A GROWING GRAIN CROP.

By A. E. Wells.

INTRODUCTION.

One of the causes that led up to the complaint by the people of Solano County against the smoke from the Selby smelter was the belief that the smoke was present in sufficient strength over the agricultural area of the "smoke zone" to be detrimental to and to do material injury to field crops and to orchards. The claims of such damage were made also to several representatives of the Selby smelter commission during the period of the investigations.

As a result of the great number of determinations of sulphur dioxide present in the atmosphere over the farming district west and northwest of Benicia during September to December, 1913, it was evident that occasionally there was present over this district a greater concentration of sulphur dioxide than is normally present in the atmosphere of most agricultural districts.

Thus, supplementary to the work of the expert agronomists and agriculturists of this commission, who were to determine the possibility of the crops having suffered through soil contamination, it became necessary to determine whether or not the crops had suffered or were likely to suffer from occasional fumigations with sulphur dioxide gas in the concentrations found over the "smoke zone."

GENERAL PLAN OF EXPERIMENTS.

A considerable part of the field crops in the Selby "smoke zone" is barley. This crop has been considered by most smoke investigators and plant pathologists as one especially susceptible to injury by sulphur dioxide. Thus, it was decided to carry out investigations with this grain. It was decided also to devote practically all the work to this crop alone, the idea being to get as much information as possible concerning the possible injury to a crop supposed to be the most susceptible to sulphur dioxide.

The original plan for these experiments was as follows:

1. To determine the visible injury brought about by fumigations with definite concentrations of sulphur dioxide and for definite periods of time.

2. To determine the effect of any visible injury upon the yield or total growth of the crop.

3. To determine the possibility of "invisible" injury and the extent to which this can take place.

In deciding upon a method for conducting these experiments, it was thought inadvisable to try to duplicate the methods used by previous investigators. In the earlier reported experiments along these lines, the plants under investigation were placed in pots or small boxes inside closed glass cabinets or houses. Measured volumes of sulphur dioxide were added to make a definite concentration when mixed with the air of the cabinet or house. The addition and mixing of this volume of sulphur dioxide with the air in contact with the plants was called a "fumigation."

The chief objections to using a method similar to the above to gain the information desired by our experiments were as follows:

1. Plants in pots or small boxes are not growing under conditions similar to those in the field, and the abnormal condition, even if slight, might influence the susceptibility of the plant.

2. The length of time during which the plants are subjected to the action of the calculated concentrations can not be determined, for the rate of absorption or disappearance of the SO_2 from the atmosphere of the cabinet can not be calculated.

3. Owing to the comparatively few plants that can be fumigated in this manner, no satisfactory determination of the yield can be made.

In our experiments, the aim was to fumigate under conditions that were not materially different from the normal. The barley was to grow in the open field, as usual, and only occasionally and for definite periods of time was it to be subjected to the action of a definite concentration of sulphur dioxide.

In order that the results of these tests should be applicable to the barley crops growing in the Selby district, it was necessary to select for our work a field of barley that would be growing under conditions similar to those of the other fields in the "smoke zone." The agronomical and agricultural conditions of the area had been studied by Mr. E. E. Free, Prof. Charles F. Shaw, of the University of California, and their field assistant, Mr. Ralph W. Brown. In the opinion of these representatives of the commission, average "agronomic" conditions of the smoke zone were met in a portion of the barley field owned by Mr. Philip Steffens on the north side of the Vallejo-Benicia road, about one-half mile east of the Vallejo limits.

This field lies north and west of the district where smoke nuisance has been claimed. From our field notes taken during September to December, 1913, it was evident that the smoke from the Selby plant seldom, if ever, was present in determinable amounts over this field.

Thus, the location of the field in its relation to the smelter was favorable.

The chief objection to the field was the poor cultivation. The ground had been plowed and then only roughly harrowed, so that the ground was very lumpy. The grain was sown rather unevenly. In spite of these objections it was evident that the field was about as well cultivated as most of the fields in the district and that the results from this field would be applicable for the Selby "smoke zone."

APPARATUS USED IN THE EXPERIMENTS.

The apparatus for preparing a definite and properly mixed concentration of sulphur dioxide in air (see fig. 10 and Pl. XII, *B*) has been described in detail in another section of this report. Sulphur dioxide gas drawn from a tank of the liquid is passed through a capillary meter into the intake side of a small blower, which delivers the mixture of sulphur dioxide and air into a galvanized-iron baffle box, and then into a galvanized-iron delivery pipe.

The motor of the blower was driven from a 110-volt A. C. power line, the power being carried from a central pole to the motor by extension cords.

The fumigation cabinets (Pl. XIV, *A*) were framed with wood, and covered on the top, sides, and ends with celluloid sheets 0.4 mm. thick. The front end of the cabinet had a round hole through which the delivery pipe from the blower was inserted. The back end was opened sufficiently to allow the escape of the air from inside. The cabinets were built 121 cm. wide, 610 cm. long, and 76 cm. high. The ground area thus covered was 7.4 square meters, the contents 5.6 cubic meters. After the first few weeks one of these cabinets was cut in half, and the halves, 305 cm. long, were used for certain experiments.

The cabinets weighed about 70 kilograms. They were equipped with handles at the ends and were easily carried from plat to plat by two men.

RECORDS KEPT IN THE EXPERIMENTS.

The volume discharged into the cabinet by the fan was determined by measuring, with Pitot tubes and a suitable manometer, the velocity of the air in the delivery pipe between the mixing box and the fumigation cabinet. All gas volumes referred to in the report of this work are at atmospheric temperature and pressure unless otherwise stated.

During most of the fumigations records were kept of the temperature and relative humidity of the outside air—that is, the air being blown into the cabinet. Records were also kept of the temperature and humidity at the farther end of the cabinet. Lloyd's hygrodeiks

were used for most of these readings, and these were checked from time to time by a sling psychrometer.

The calculated sulphur dioxide concentrations were checked very frequently by analyses. The method of analysis was the modified Selby Smelter Commission method used in the regular field work. At the beginning of the work analyses of the mixtures blown over the plants were made during every fumigation. Later the analyses were made over the range of concentrations used with each fumigation outfit, twice or three times per week. In nearly all cases the concentrations of the sulphur dioxide in the volume blown into the cabinet as determined by analyses checked within 10 per cent of the calculated concentrations. The concentration at the far end of the cabinets was invariably lower. This feature will be discussed below.

GENERAL DISCUSSION OF RESULTS.

After the first few experiments, it was evident that by this method of fumigation we were producing visible injury and bleaching on the vegetation with very much lower concentrations of sulphur dioxide than were thought could possibly do damage. Because of this discrepancy from the results reported by previous investigators, we have investigated very carefully the conditions that could influence the susceptibility of the grain. Furthermore, we have carried on experiments both in the field and in the laboratory, using the method of fumigation employed by many previous investigators, and are able to show wherein lies the cause for the discrepancy of these from earlier reported results.

The first fumigations were of comparatively long duration. Most of them were of one-hour duration; one was continued for four hours; and one for eight hours per day. Check plats were fumigated at the same time with the atmosphere of the field which contained no determinable amount of sulphur dioxide. Inasmuch as the check plats showed no signs of injury whatever, except an occasional mechanically bruised leaf at one or the other end of the plat, it was evident that any injury on the plats fumigated with sulphur dioxide must certainly be due to the gas.

However, the question arose as to whether or not the plants were rendered especially susceptible to the gas, owing to the change in the temperature and humidity brought about by placing the cabinet over the grain. It is true that during the long-time fumigations, with the long cabinets first used, the temperature at the far end of the cabinet was invariably higher than at the inlet. On hot sunny days, the temperature was as much as 14° C. higher at this point than at the intake. There was frequently a considerable difference in the relative humidity; sometimes higher, at other times lower at the far end than at the inlet end. However, the worst injury was

A. FUMIGATION CABINET.

B. GENERAL VIEW OF EXPERIMENTAL FIELD AT VALLEJO.

invariably found in the first part of the plat, in fact, directly in front of the delivery pipe, where the temperature and humidity were that of the air being blown in, and where no abnormal change took place.

In order to determine the effect of temperature and humidity on the susceptibility of the plants, fumigations were conducted under various conditions. It was found that the humidity was of great importance in affecting the susceptibility of the plants; of far greater importance than the change of temperature or of the influence of sunlight and shade.

A fumigation lasting an hour or longer was not considered to be comparable to actual conditions existing in a smelter-smoke zone, certainly not in the Selby smoke zone. In our field analytical work in the Selby district it was found that a concentration as high as 1 part sulphur dioxide per million of air might exist for a considerable period. On a few rare occasions a concentration of 2 parts was found to persist about 20 minutes at a time. Concentrations above that amount were found only at long intervals and for only a few minutes at a time.

Thus it was decided to carry on some fumigations, each of only 10 or 15 minutes' duration, but repeated frequently. Other fumigations were carried out in 5-minute doses. Still others received only 2-minute doses. These short-period fumigations eliminated to a great extent, if not completely, the temperature and humidity changes during the fumigations. As is shown later, the temperature and humidity changes at the far end of the cabinets during the 5-minute fumigations were very slight. The 2-minute fumigations were conducted under shorter cabinets and the air was blown in at both ends, thus eliminating any changes whatever in temperature and humidity.

The fact that the barley field at Vallejo was rather poorly cultivated and planted gave rise to the question concerning the influence of poor cultivation upon the susceptibility of the plants to sulphur dioxide. It was thought possible that the barley was rendered especially susceptible by reason of the poor cultivation. Thus, it was considered desirable to carry on similar experiments on barley that had been well planted in a well-cultivated field, to determine whether the results would check those obtained at Vallejo. By courtesy of the dean, H. E. Van Norman, and associates at the university farm at Davis, we were able to conduct a series of experiments there, checking the work at Vallejo. Many experiments were carried on at Davis in the same manner as at Vallejo, and practically the same results were obtained. Thus, it is evident that the factor of poor cultivation did not materially influence the results.

When the long 610-cm. cabinets were used it was found by analysis that the concentration of the sulphur dioxide at the far end of the

cabinets was considerably lower than at the inlet. No air was allowed to leak into the cabinet. In fact, the air inside the cabinet was usually leaking out around cracks, etc. Thus, there could be no dilution with sulphur dioxide free air. The decrease in concentration must, therefore, have been due to absorption of the sulphur dioxide by the vegetation, soil, and celluloid. That this absorption by vegetation and soil is extremely rapid was proven in special experiments in the field and in the laboratory.

The rate of decrease in concentration was not constant, but was dependent upon the moisture present in the soil or on the foliage, also upon the height and stage of growth of the plants. In one fumigation, when the soil was wet and the plants had drops of water standing on them, 75 per cent of the sulphur dioxide was absorbed in the passage of the air through the cabinets.

At Davis it was found that there was an absorption of about 40 per cent of the sulphur dioxide between the front and back of the cabinet when the ground and vegetation was quite dry and the barley was about 46 cm. high. The fan was discharging into the cabinet about 5.1 cubic meters per minute, containing 25.5 c. c. or 0.013 gram of SO_2 per cubic meter. Of all the analyses made in the long cabinets both at Vallejo and Davis the average concentration at the far end was found to be about 66 per cent of the concentration at the inlet. This explains why on many plats less damage was found at the far end than at the inlet end.

In order to maintain more nearly the same concentration throughout the length of the cabinet, it was necessary to increase the volume discharged into the cabinet or else decrease the length or volume of the cabinet. For this purpose a larger fan was obtained for the Vallejo work. This object was accomplished also by using a fan at both ends of the cabinet and allowing the air to escape through the center. To an even greater degree this was accomplished by reducing the length of the cabinet to 300 cm. and blowing the mixture in at both ends. In this last scheme of fumigation the foliage was kept in motion throughout the whole plat by the force of the wind currents. This last method eliminated any criticism arising from the fact that in the long cabinets, with air being blown in at only one end, the foliage at the far end was in a relatively quiet atmosphere, and thus subjected to an abnormal condition.

At Davis the larger fan did not deliver the volume desired, due to the drop in voltage over a longer and smaller transmission line. Thus we found a greater difference in the concentration at the two ends of the cabinet and, as a result, a great difference in the injury at the two ends.

DETERMINATION OF THE YIELD OF THE PLATS.

The determination of the comparative yield of the fumigated and checked plats was one of the chief objects in this work. At Vallejo, due to the uneven planting and the rough character of the soil, the number of plants in the plats was variable. At both Davis and Vallejo, due to variations in the moisture content of the soil and other natural causes, the height of the plants in the plats also varied. Thus, it would be difficult and lead to wrong conclusions to base the comparison of the yields of the plats upon the area unit.

Our observations during the work showed that no plants were killed, even under the most severe treatment given, and that the normal amount of stooling appeared to take place in practically all cases. Thus, the logical basis for comparing the yields is the yield per stalk or head.

In the comparison of the yields from these experimental plats the total yields are compared on the basis of the "total weight of heads and straw" per unit head. The grain yield is based on the average weight of the grain thrashed from each good head. As will be noted, the percentage of good heads—that is, heads free from mold—was greater in the fumigated than in the unfumigated plats. In some of the fumigated plats the percentage of good heads was much greater than in the check plats, which indicated that the sulphur dioxide served to kill the mold. As a supplementary note in many of the tables in which the yields have been compared the comparison has been made of the weight of "grain" per unit "total head."

The barley in a strip (approximately 61 cm. by 461 or 273 cm.) through the center of the plats was cut by hand. The barley was cut close to the ground, tied in bundles properly tagged, and placed inside coarse-mesh cotton bags and allowed to dry several days. The total weight of each sample was then determined and the number of stalks or heads was counted. The moldy heads were discarded during the counting, but included in the total count. The good heads were then thrashed carefully by hand and the chaff winnowed. The weight of the grain in each sample was then carefully determined. Then 100 kernels of grain from each sample were counted out and the weight of this number carefully determined. Thus, the following data were determined by counting and weighing: (1) Total weight of straw and heads; (2) total number of heads; (3) number of good heads—that is, heads free from mold; (4) weight of grain; and (5) weight of 100 kernels.

From these data the following details could be calculated for the purpose of comparison: (1) Total weight of straw and heads per unit head; (2) weight of grain per unit head; (3) number of kernels

per head; (4) percentage of good heads to the total; and (5) relative yield based on values 1 and 2.

The check plats were in many cases fumigated, for the same length of time and under the same conditions as the plats with which they were compared, with the atmosphere of the field which contained no determinable amount of sulphur dioxide. At no time during the fumigation work did the check plats show any visible injury due to being under the cabinets. There was not even an increase in the amount of bacterial disease in the checks fumigated under cabinets above those that were never fumigated at all.

Samples were taken through the center of the plat to eliminate any foliage or heads in the outside rows that might have been bruised by the cabinet, etc.

In the discussion and notes concerning the injury to the barley two types of injury will be referred to, as follows: (1) The mottled type, and (2) the "concentrated" or kill-back type.

Mottled type of bleach.—This type of injury was first observed on the short-period fumigations with the very dilute gas. The primary appearance of this type of injury is as illustrated in Plate XII, *C*, and Plate XV.

The developed mottled type of bleach.—As the first "mottled" type of bleach develops it becomes more like the bleach as shown in the leaves held up for inspection in Plate XVI, *A*.

The "concentrated" or "kill-back" type of bleach.—This type of bleach appeared wherever the barley had had a very severe dose. In general the barley is bleached white continuously back from the tips. When the leaf has received this type of bleach at the end it usually has considerable bleach of the "developed mottled" type closer to the stem.

FUMIGATION EXPERIMENTS AT VALLEJO.

The work at Vallejo was started on March 20, 1914, when the plants were about 7.5 to 10 cm. high and had from two to four leaves stooled out.

The part of the field in which these experiments were made had been plowed in December. A moldboard plow was used. It was seeded early in March with a broadcast seeder and the seeding followed by a rough harrowing.

The ground was so rough and so many bumps were present that it was difficult to place the cabinets squarely on the ground. In fact, in laying out most of the plats it was necessary to use a hoe or small shovel to remove lumps or fill in depressions so that the cabinet would sit squarely on the ground.

GRADUATIONS OF SULPHUR DIOXIDE INJURY FROM "INCIPIENT MOTTLED" TO "CONCENTRATED" OR "KILL-BACK" TYPES.

A. DEVELOPED "MOTTLED" TYPE OF BLEACH.

B. GRAIN IN PLAT 59, MAY 2, 1914, AFTER SECOND FUMIGATION.

C. CHARACTER OF BLEACH ON PLATS 33, 34, AND 35, APRIL 27, 1914, AFTER EIGHTY 5-MINUTE FUMIGATIONS.

The plats were laid out in rows, from 60 to 120 cm. being allowed between each plat. Plate XIV, *B*, gives a general view of experimental field at Vallejo.

The experimental work at this field was planned and is here discussed under the following classification:

Series 1.—Experiments to determine the effect of one or two comparatively strong fumigations made (*a*) during early stages of growth, while the plants were less than 15 cm. high; (*b*) during the time between that included in *a* and the "heading-out" stage; (*c*) during the period when the grain was developing, while the grain was in the "milk" or "dough" stages.

Series 2.—Experiments to determine the effect of fumigating for 10-minute periods for an average of once per day during the entire growing season with definite concentrations of sulphur dioxide.

Series 3.—Experiments to determine the effect of three fumigations per day, each of five minutes' duration, during the entire growing season, with definite concentrations of sulphur dioxide.

Series 4.—Experiments to determine the effect of a considerable number of 5-minute fumigations after the plants had stooled out.

Series 5.—Experiments to determine the effect of a considerable number of 2-minute fumigations while the grain was forming in the head, "in the milk."

Series 6.—Experiments to determine the effect of fumigations with very dilute gas for comparatively long periods daily during the whole growing season.

Series 7.—Experiments expressly to determine the possible existence of "invisible injury."

Series 8.—Miscellaneous experiments to determine the influence of humidity, sunlight, and shade upon the susceptibility of the plants to sulphur dioxide.

Series 9.—Experiments to determine the relative injurious effect of sulphur-dioxide gas and sulphur-trioxide fume and vapor.

Series 10.—Special experiments.

EXPERIMENTS IN SERIES 1*a*.

Series 1*a* included the plats that received either one or two strong fumigations with sulphur dioxide during the early stages of growth—that is, when the plants were less than 15 cm. high.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

VISIBLE EFFECTS OF FUMIGATIONS.

A continuous fumigation for an hour with 3 or more parts of SO_2 per million parts of air by volume (0.0080 gram of SO_2 per cubic meter) on barley when the plants were less than 15 cm. high caused visible bleaching. With concentrations of over 5 parts of SO_2 per million, the injury was great, more than two-thirds of the foliage being bleached. The injury produced was principally the "concentrated" or "kill-back" type. Severe bleaching was also produced by repeated long-time fumigations with a concentration as low as 1 part of SO_2 per million. The bleach developed most rapidly in sunlight.

EFFECT OF SINGLE FUMIGATIONS ON YIELD.

One severe bleaching of the plants during this period of growth did not cause an appreciable decrease in the yield. The total weight of crop cut from the fumigated plats averaged within 1 per cent of the yield from the check plats. The weight of the "grain" itself averaged only 2 per cent less than that of the check plats.

EFFECT OF A DOUBLE FUMIGATION ON YIELD.

In the two treated plats a decrease of about 10 per cent was found in the "total weight" of each crop. One plat showed no decrease in the "grain" yield, the other showed 20 per cent decrease. The first plat received its "kill-back" fumigation about eight days earlier than did the second. Thus it had a better chance to recover. Little rain fell after the last of these fumigations, and the soil dried up rapidly.

In discussing the recovery of crops from severe injury caused by sulphur dioxide, it must be remembered that the nature of the season is a factor of great influence on the results. In a season when there is plenty of rain plants injured in the early stages of growth would have a better chance to recover and give a normal yield than in a season of drought. The winter season at Vallejo was a wet one and the soil was well supplied with moisture at the beginning of the growing season. However, after April 1 there was little precipitation, and the soil dried up rapidly and cracked badly. Thus the conditions at the Vallejo field were not especially favorable for the recovery of the plants from injury.

Summary of results of experiments in series 1a, Vallejo.

[Fumigations made when the barley plants were less than 15 cm. high.]

SINGLE SEVERE BLEACH.

Plat No.	Concentration of SO_2.		Length of fumigation.	Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—		Remarks.
	Parts per million.	Grams per cubic meter.			Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.	
			Hours.		*Grams.*	*Grams.*	*Grams.*		*Per ct.*	*Per ct.*	
Check	.....	.....	1	202	2.54	1.17	3.68	32	100	100	Of the total number of heads from the check plat, only 89 per cent were free from mold. No. 8 and No. 9 had 90 per cent and 94 per cent good heads out of the total. Basing the relative grain yield of No. 8 and its check on the weight per unit total head, the plat No. 8 yielded 103 per cent of the check's yield.
1	10	0.0262	1	226	2.47	1.13	3.90	29	97	96	
2	5	.0131	1	199	2.50	1.16	3.64	32	98	99	
Check	0	0	1	214	2.51	1.12	3.61	31	100	100	
3	4	.0106	1	192	2.47	1.21	3.66	33	98	108	
Check	0	0	1	195	2.44	1.33	3.92	34	100	100	
6	5	.0131	1	188	2.37	1.19	4.27	28	97	90	
Check	0	0	43	288	2.88	1.33	4.28	31	100	100	
8	2	.0052	12	248	2.94	1.30	3.67	36	102	98	
9	1	.0026	43	320	2.85	1.30	4.05	32	99	98	

REPEATED SEVERE BLEACHES.

Check	0	0	[a] 2	200	2.54	1.17	3.68	32	100	100	If the comparative grain yields of No. 22 and its check were based on the weight of grain per total heads, the yield from No. 22 would be 88 per cent of the check.
11	20	.0524	1	.....	.....	.....	.....	.....	.....	.....	
	10	.0262	1	207	2.29	1.19	4.05	29	90	102	
Check	.....	.....	.....	224	2.95	1.59	4.21	38	100	100	
22	10	.0262	1	.....	.....	.....	.....	.....	.....	.....	
			1	238	2.56	1.29	4.14	31	87	81	

[a] Two 1-hour fumigations.

PLAT 1.

Approximate average height of plants, 10 centimeters.

Date of fumigation, March 20, 1914.

Time of fumigation, 1 hour (12.45 to 1.45 p. m.).

Volume of air through cabinet, 3.8 cubic meters per minute.

Volume of SO_2 added to air, 38 c. c. per minute.

Calculated concentration, 10 parts SO_2 per million by volume (0.0262 gram per cubic meter).

Concentration found by analysis—At inlet, 9.8 parts SO_2 per million by volume; at outlet, 6.2 parts SO_2 per million by volume.

Cabinet temperature—average at inlet, 26° C.; average at outlet, 36° C.

Cabinet relative humidity—average at inlet, 52 per cent; average at outlet, 40 per cent.

Notes.

Sunlight. Before the end of the hour the leaves had wilted down and become faded green. They did not begin to bleach until after the hood was removed. By 5 p. m, about 90 per cent of the leaves had bleached to the "concentrated" or "kill-back" type.

March 21.—All blades affected, oldest leaves more so than the youngest. Total percentage of leaf area bleached about 90 per cent. Plants at back end of the hood not so badly affected as in the front, near the inlet.

March 28.—New shoots of barley coming up. The bleached leaves not recovering where burned close to the ground, but where tops only were bleached the leaves continue to grow. Bleached foliage now white.

March 30.—New shoots growing very rapidly after rain of March 29 and 30.

April 3.—Few bleached leaves showing. New green shoots predominate. Grain not so far advanced as corresponding check plat 1*a*.

April 6.—Practically all signs of bleached leaves disappeared. All foliage green, but not so high as in check plat.

After April 12 no trace of any previous sulphur dioxide injury was visible. The plants near the front of the plat were smaller and the stand was thinner than in the back or in the check plat. It was evident that this thinner stand was due to poor soil conditions and poor planting rather than to the previous bleaching. During May the leaves began to turn yellow, partly due to bacterial disease and partly to maturity, similar to the rest of the field. The plat and its check were cut on June 26. Area sampled, 2.8 square meters.

PLAT 2.

Approximate average height of plants, 10 cm.

Date of fumigation, March 20, 1914.

Time of fumigation, one hour (10 to 11 a. m.).

Volume of air through cabinet, 3.8 cubic meters per minute.

Volume of SO_2 added to air, 19 c. c. per minute.

Calculated concentration, 5 parts SO_2 per million by volume (0.0131 gram per cubic meter).

Concentration found by analysis—at inlet, 4.8 parts SO_2 per million by volume; at outlet, 3.2 parts SO_2 per million by volume.

Cabinet temperature—average at inlet, 24° C.; average at outlet, 32° C.

Cabinet relative humidity—average at inlet, 52 per cent; average at outlet, 56 per cent.

Notes.

Partly cloudy. At the end of hour's fumigation the leaves were generally wilted and slightly faded. In the afternoon the leaves began to bleach.

March 21.—The ends of all blades were bleached yellowish white, the bleach extending continuously back from the tips. Over part of the broad leaves there is a slight white mottling. Area bleached equals about 50 per cent of the total.

March 28.—New green foliage appearing as new shoots.

March 30.—The new shoots are growing rapidly. The old bleached leaves are now quite white and have not recovered to any extent.

April 3.—The old bleached leaves are lying on the ground. The new foliage predominates.

April 6.—Practically all signs of bleached leaves have disappeared. No bleach on the leaves now standing.

After April 12 there were no signs of the sulphur dioxide bleach. The plants appeared to be perfectly normal in size and in general appearance.

During May the yellow rust appeared on the leaves as in the rest of the field.

The plat was cut on June 26.

Area sampled, 2.8 square meters.

PLAT 3.

Approximate average height of plants, 10 cm.

Date of fumigation, March 20, 1914.

Time of fumigation, one hour (11.30 a. m. to 12.30 p. m.).

Volume of air through cabinet, 3.8 cubic meters per minute.

Volume of SO_2 added to air, 15.2 c. c. per minute.

Calculated concentration, 4 parts SO_2 per million by volume (0.0104 gram per cubic meter).

Concentration found by analysis—at inlet, 4.1 parts SO_2 per million by volume; at outlet, parts SO_2 per million by volume not determined.

Cabinet temperature—average at inlet, 26° C.; average at outlet, 34° C.

Cabinet relative humidity—average at inlet, 48 per cent; average at outlet, 40 per cent.

Notes.

Sunlight. At the end of the hour's fumigation the leaves began to show signs of wilting and the faded green color was noted. By 5 p. m. the bleaching became apparent.

March 21.—The ends of the leaves are practically all bleached to a nearly white color, although many are yellowish white. The bleaching extends uniformly back from the tip. Only slight "mottling" appears. About 30 to 40 per cent of the total area bleached.

March 28.—Very rapid growth of new shoots noted. The old leaves also growing, although the bleached tips appear to be dead.

March 30.—Rapid growth after rains of March 29 and 30.

April 3.—With the exception of a few white tips practically all the leaves standing are green. Very few signs of old bleach remain.

April 6.—Plat appears green except for a few dead leaves around the base of the plant.

April 12.—After this date there were no traces of the old bleach. The plants appear normal, although the stand is thin. About the same as the checks in general appearance throughout the rest of the growing season.

Plat cut June 26.

Area sampled, 2.8 square meters.

PLAT 4.

Approximate average height of plants, 10 cm.

Date of fumigation, March 21 and 22, 1914.

Time of fumigation, March 21, 9.50 to 10.50 a. m.; March 22, 11.30 a. m. to 12.30 p. m.—total, two hours.

Volume of air through cabinet, 3.5 cubic meters per minute.

Volume of SO_2 added to air, 10.5 c. c. per minute.

Calculated concentration, 3.0 parts SO_2 per million by volume, 0.0078 gram per cubic meter.

Concentration found by analysis—at inlet, 3.0 parts SO_2 per million by volume; at outlet, 2.3 parts SO_2 per million by volume.

Cabinet temperature—average at inlet, 20° C.; average at outlet, 25° C.

Cabinet relative humidity—average at inlet, 55 per cent; average at outlet, 59 per cent.

Notes.

Partly cloudy. After first fumigation the leaves began to turn a darker, faded green and to droop slightly.

March 22.—In the morning many of the leaves were slightly "mottled" or bleached. After the second fumigation the drooping and discoloration of the leaves was much more noticeable. By 5 p. m. the bleeching of the leaves was very evident.

March 23.—About 20 per cent of the total foliage is bleached or "mottled" worse on the first and second leaves than on others.

March 30.—New growth of foliage is rapidly obliterating the old bleached leaves.

April 6.—All signs of old bleach gone.

April 12.—After this date the growth of the plants appeared normal, but the stand was very short and thin, due to the poor soil condition.

This plat was so uneven and the ground was so badly cracked in May and June that it was not cut for quantitative results.

PLAT 5.

Approximate average height of plants, 9 to 10 cm.

Date of fumigation, March 21 and 22, 1914.

Time of fumigation, 2 hours—March 21, 11 a. m. to 12 m.; March 22, 2.15 to 3.15 p. m.

Volume of air through cabinet, 3.5 cubic meters per minute.

Volume of SO_2 added to air, 7 c. c. per minute.

Calculated concentration, 2 parts SO_2 per million by volume, 0.0052 gram per cubic meter.

Concentration found by analysis—at inlet, 2.2 parts SO_2 per million by volume; at outlet, 1.6 parts SO_2 per million by volume.

Cabinet temperature—average at inlet, 20° C.; average at outlet, 27° C.

Cabinet relative humidity—average at inlet, 59 per cent; average at outlet, 63 per cent.

Notes.

Cloudy. At the end of the first fumigation there was a slight drooping and darkening of a few leaves. No bleaching appeared before evening.

March 22.—No bleach showed in morning. After second fumigation the drooping was more pronounced.

March 23.—The first half shows distinct bleaching with some "mottling" on leaves in the back end of the plat. About 10 per cent of area bleached.

March 30.—Most signs of bleaching have disappeared, except for a few leaf tips.

April 6.—No signs of first bleaching were present. From this date on the appearance of the plat was perfectly normal. The stand was very thin and the plants were short

due to poor soil and cultivation. As the soil in this plat became badly cracked due to dry spell in May, the yield was abnormally low and the plat was not cut for quantitative results.

PLAT 6.

Approximate average height of plants, 8 to 12 cm.

Date of fumigation, March 23, 1914.

Time of fumigation, one hour (10.30 to 11.30 a. m.).

Volume of air through cabinet, 3.8 cubic meters per minute.

Volume of SO_2 added to air, 19 c. c. per minute.

Calculated concentration, 5 parts SO_2 per million by volume (0. 131 gram per cubic meter).

Concentration found by analysis—at inlet, 4.9 parts SO_2 per million by volume; at outlet, 4 parts SO_2 per million by volume.

Cabinet temperature—average at inlet, 21° C.; average at outlet, 24° C.

Cabinet relative humidity—average at inlet, 60 per cent; average at outlet, 68 per cent.

Notes.

Cloudy. Due to the moist condition of the soil, the relative humidity at the far end of the cabinet during the fumigation was higher than outside. The plants began to droop and darken during the fumigation time. Bleaching did not begin to show until later in the afternoon. Plat 6*a* received the same treatment except no sulphur dioxide was added.

March 24.—Early in the morning the leaves were not changed greatly in appearance from the evening of the 23d. By noon, however, the sun came out bright and the leaves bleached rapidly. At 5 p. m., in the front part of the plat, the leaves were practically 70 to 80 per cent bleached, the bleached area extending solidly back from the tips. In the back part of the plat the leaves were not so badly bleached. It is to be noted that the damage to the leaves in plat 6 was apparently greater than in plat 2, which received the same treatment, but under lower humidity conditions.

March 30.—The rains on March 29 and 30 have hastened the rapid growth of the new foliage in the plat. New shoots are coming up from every plant, which fact bears out our observations on the other plats previously fumigated, that even by very severe injury no plants are actually killed.

April 6.—Little evidence of the bleach now remains. Some of the leaves show bleached tips.

April 12.—No evidence of bleach in any part of the plat. Plants are somewhat shorter than in plat 6*a*. Plants in both 6 and 6*a* slightly shorter than plants in other parts of the field (see Pl. XVII, *A*).

From this time on the two plats were alike and normal in every way. The grain on the two plats, as the grain in the immediate vicinity outside the plats, was slow in ripening. Although the greater parts of the plats were ready for harvest on June 26, it was necessary to wait until July 2 before harvesting plats 6 or 6*a*.

Area sampled, 2.8 square meters.

PLAT 8.

Approximate height of plants, 10 to 15 cm.

Date of fumigations, March 20, 21, and 22.

Time of fumigations, 4 hours each day—12 hours total.

Volume of air through cabinet, 3.8 cubic meters per minute.

Volume of SO_2 added to air, 7.6 c. c. per minute.

Calculated concentration, 2 parts SO_2 per million by volume (0.0052 gram per cubic meter).

Concentration found by analysis—at inlet, 2.1 parts SO_2 per million by volume; at outlet, 1.6 parts SO_2 per million by volume.

Cabinet temperature—average at inlet, 25° C.; average at outlet, 32° C.

Cabinet relative humidity—average at inlet, 52 per cent; average at outlet, 57 per cent.

Notes.

Sunny. At end of the first four hour's fumigation a few of the leaves were drooping slightly.

March 21.—Slight bleaching evident before the second fumigation. At the end of second fumigation the leaves are drooping slightly more than in the morning. The tips of the leaves are slightly faded and appear to be injured.

March 22.—Bleaching evident all over the plat in morning. At the end of the third fumigation the bleached area is increased. Probably 25 to 30 per cent of total leaf area affected. Fumigations are stopped to let damage develop.

March 24.—The injury to the leaves very general. Bleach probably fully developed and covers about 30 per cent of the leaf area. General solid "concentrated" type bleach back from tip, but some "mottling" shows.

March 30.—The barley is recovering very rapidly due to the rains of March 29 and 30. The portions of leaves affected apparently not reviving, but the new growth is obliterating the bleached areas.

April 3.—Except for slight bleached area on the tips of a few leaves the plants appear perfectly normal and similar to those in check plat 10.

April 6.—The plants in this plat appear perfectly normal and are as high as in the average check plat. No signs of previous damage now show. Plants somewhat thinner stand in front of plat than in back.

After April 6 the development of the plants in this plat was perfectly normal. The plants were as high though not so thick as in the check plat 10 or the fumigated plat 9. The plants in Nos. 8, 9, and 10 were higher than those in Nos. 1, 2, 3, 4, and 5. The grain ripened at about the same time as No. 9 and No. 10 and was cut on June 26.

Area sampled, 2.8 square meters.

PLAT 9.

Approximate height of plants, 10 to 15 cm.

Date of fumigation, March 20 to 25, 1914.

Time of fumigation, 43 hours (5 7-hour periods and 1 8-hour period).

Volume of air through cabinet, 3.8 cubic meters per minute.

Volume of SO_2 added to air, 3.8 c. c. per minute.

Calculated concentration, 1 part SO_2 per million by volume (0.0026 gram per cubic meter).

Concentration found by analysis—at inlet, 1 part SO_2 per million by volume; at outlet, 0.6 part SO_2 per million by volume.

Cabinet temperature—average at inlet, 27° C.; average at outlet, 35° C. (maximum 40° C.).

Cabinet relative humidity—average at inlet, 55 per cent; average at outlet, 60 per cent.

A. PLANTS IN PLATS 6 AND 6*a* ON APRIL 15, 1914.

B. GRAIN IN PLAT 16 ON APRIL 27, 1914.

Notes.

March 20.—No signs of bleaching or drooping at end of first six-hour fumigation.

March 21.—Very slight "mottling" appeared at end of second fumigation; that is, after 14 hours of fumigation.

March 22.—Increase in number of "mottled" leaves more general near the front of the plat.

March 23.—Appearance of leaves about the same as noted on March 22.

March 24.—Slight increase in extent of "mottled" area near front of plat—about 5 to 10 per cent of area "mottled" in front. Very slight in back.

March 25.—The "mottling" is gradually changing to the "developed mottle" and "concentrated" bleach extending back from tips and between the veins. The back parts of the plat still show only slight effects. Fumigations ceased.

March 30.—White tips still evident. Plants are growing very rapidly, after the rains of March 29 and 30, and the percentage of total area that is bleached is decidedly decreased.

April 3.—Very few leaves showing the bleach now. Plants about normal in size as compared with those in plat 10.

April 6.—Practically all signs of previous bleach have disappeared. The plants look to be the same in size and in every way with those of plat 10.

After April 12 the plat appeared almost the same in every way as plat 10, though the stand was probably thicker in plat 9 than in plat 10. The grain in plat 9 ripened at the same time as that in plat 10 and was cut on the same day, June 26.

Area sampled was 2.8 square meters.

PLAT 11.

Approximate height of plants, 7.5 to 10 cm., first fumigation; 10 to 13 cm., second fumigation.

Date of fumigation, first, March 20, 1914; second, April 2, 1914.

Time of fumigation, one hour each time.

Volume of air through cabinet, 3.5 cubic meters per minute.

Volume of SO_2 added to air, first fumigation, 70 c. c. per minute; second fumigation, 35 c. c. per minute.

Calculated concentration, first fumigation, 20 parts SO_2 per million by volume (0.0524 gram per cubic meter); second fumigation, 10 parts SO_2 per million by volume (0.0262 gram per cubic meter).

Concentration found by analysis, first fumigation, at inlet, 18.5 parts SO_2 per million by volume; second fumigation, at inlet, 10.2 parts SO_2 per million by volume; first fumigation, at outlet, 12 parts SO_2 per million by volume; second fumigation, at outlet, 7.8 parts SO_2 per million by volume.

Cabinet temperature, at inlet, 26° C.

Notes.

March 20.—The object of this fumigation was to bleach the leaves completely. The leaves began to wilt and fade in about 15 minutes. At the end of an hour all leaves lying flat on the ground and bleaching very rapidly.

March 21.—Practically all leaves injured back to the ground. In some cases the leaves retain their faded green coloring. In all cases injury extends solidly from the tips. No "mottling." Injury worse at the front than at the back. Wild turnips in the plat also very severely injured.

March 30.—The plants are reviving very rapidly in the rains. No indication of any plant having been killed outright, for shoots are coming up from every one of the original plants. Of course the plants are behind the others in growth.

April 2.—Tips of many leaves still show signs of first bleach. Plants are decidedly smaller than in the check plats. Plants seem to have outgrown the original bleach considerably. On this day the plat was subjected to a second fumigation of one hour with a concentration of 10 parts SO_2 per million. At the end of the hour's fumigation the plants are again wilted and faded.

April 3.—Leaves of all plants bleached again. The plants look about as did the plants in plat 1, after the fumigation of March 20. The fumigation means practically the same as cutting the grain back to the ground.

April 6.—From every plat green shoots are coming up. No plants killed. New shoots growing very rapidly, but much shorter than the check.

April 20.—On a few leaves the tips were still white, but practically all signs of previous damage are eliminated. The plants are much shorter and seemed to be thinner than are those of the check plat.

May 11.—Plants are still shorter and not so far advanced as those in the check. Appear to be almost two weeks behind.

May 21.—Plants in plat 11 shorter than in check, but the heads are filling out. Will probably mature the grain soon after the check.

May 29.—Grain in plat 11 is greener than in check.

June 26.—The grain in plat 11 was sufficiently ripe to cut. In the check plat the grain had been equally ripe for several days. Thus the setback was not greater than one week at the end. Check plat also cut on June 26.

Areas sampled, 2.8 square meters.

PLAT 22.

Approximate height of plants, 10 to 15 cm.

Date of fumigation, March 28 to April 10, 1914.

Time of fumigation, one hour each time.

Volume of air through cabinet, 3.5 cubic meters per minute.

Volume of SO_2 added to air, 35 c. c.

Calculated concentration, 10 parts SO_2 per million by volume (0.0262 gram per cubic meter).

Concentration found by analysis, not made.

Cabinet temperature, average at inlet, 20° C.

Cabinet relative humidity, average at inlet, 58 per cent.

Notes.

March 28.—This fumigation was made during cloudy conditions, and, although the plants wilted down and faded somewhat, the bleach did not appear during the day.

March 30.—Not until the sun came out during the afternoon to-day did the bleach fully develop. Now the leaves appear bleached back solidly from the tips. No "mottling" showing. Most leaves are lying down on the ground. Injury done to about 90 per cent of the total foliage. The leaves that were wet during the fumigation are twisted and white.

April 2.—Green shoots coming up. No plants killed.

April 6.—Plants growing very rapidly. Marks of old injury still evident, though proportion to total foliage is less than 20 per cent.

April 11.—Morning. Except for a few tips the leaves are quite free from the marks of the old injury. Fumigated this date with 10 parts SO_2 per million parts of air for

one hour. The leaves wilted down, faded, and bleached in a short time. Practically all the "kill-back" type bleach.

April 20.—Plants are recovering very rapidly. Much of the bleach caused by the fumigation of the 11th still visible. New foliage in good green condition.

May 1.—Plants in plat 22 are practically all free from old injury and the grain developing normally. Plants are much shorter than the plants in the check plat.

May 11.—Plants are shorter than the check plats, but are heading out in the same manner as the check. No signs of former injury to leaves.

May 29.—It is now difficult to distinguish between the fumigated plat 22 and the control plat 22*a*, for both are about the same in height and general appearance.

June 15.—It is evident that the grain in plat 22 will ripen a few days later than in the check plat. Both are somewhat behind the plats in the other parts of the field.

June 26.—Neither plat 22 nor 22*a* is quite ready for harvesting. Some of the heads are still green.

July 2.—Both plat 22 and the check plat harvested.

Area sampled, 1.67 square meters.

Results of experiments in series 1a, Vallejo.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	2.8	1,415	558	508	91	597
1	2.8	1,560	632	574	91	647
2	2.8	1,415	566	490	87	567
Check	2.8	1,502	599	547	91	615
3	2.8	1,332	538	496	92	601
Check	2.8	1,332	546	454	83	606
6	2.8	1,246	526	444	84	530
Check	2.8	2,322	806	716	89	955
8	2.8	2,041	604	654	94	852
9	2.8	2,549	895	803	90	1,042
Check	2.8	1,415	558	508	91	597
11	2.8	1,332	581	512	88	608
Check	1.67	1,105	375	324	86	515
22	1.67	1,018	398	371	93	478

EXPERIMENTS IN SERIES 1b.

In this series are the plats that received from one to three strong fumigations of sulphur dioxide between the time the plants were 15 cm. high and the time when the grain was heading out. In this subdivision are included only those plats fumigated during this period for the purpose of obtaining quantitative results on the yields. The plats fumigated under various humidity conditions, etc., to determine only the influence of humidity on the susceptibility of the plants to sulphur dioxide at this stage of growth, are discussed elsewhere. Thus the plats in this series are plat 46 and its check, and plats 58, 59, 60, and 61, and their check plat.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

VISIBLE EFFECTS OF FUMIGATIONS.

As a result of an hour's fumigation of 5 parts SO_2 per million parts of air by volume (0.013 gram SO_2 per cubic meter) the total area of the foliage bleached was greater than that produced by a similar fumigation during the earlier stage of growth. The proportion of this bleached area to the total foliage, however, was less. Repeated fumigations increased the extent of the bleached surfaces to more than 50 per cent of the total. The total area ultimately bleached was approximately the same, whether the fumigations were given in one or two long-time doses or a greater number of shorter doses within a few days. The injury was extremely severe in all cases.

EFFECT ON THE YIELD.

The average decrease in the total weight of "straw and heads" from the fumigated plats compared with the checks was approximately 14 per cent.

The average decrease in the yield of the "grain" was 10 per cent.

The effect upon the yield was greater than that produced by a severe bleach in the earlier stages of growth.

Summary of results of experiments in series 1b, Vallejo.

[Fumigations made when the barley plants were more than 15 cm. high, up to time of heading out—fumigations caused severe injury.]

Plat No.	Concentration of SO_2.		Length of each fumigation.	Number of fumigations.	Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.				Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
			Hours.			*Grams.*	*Grams.*	*Grams.*		*Per ct.*	*Per ct.*
Check					199	3.12	1.31	3.74	35	100	100
46	5	0.0131	1	3	210	2.41	1.35	4.42	31	77	103
Check					248	3.04	1.55	4.46	35	100	100
58	5	.0131	1	2	283	2.82	1.29	3.63	36	93	83
			Minutes.								
60	5	.0131	5	24	201	2.61	1.23	3.47	35	86	79
61	5	.0131	2	60	195	2.71	1.50	4.12	36	89	97

NOTE.—Average yield of fumigated plats, based on total weight, 86.2 per cent; based on weight of grain per good head, 90.5 per cent.

PLAT 46.

This plat was 120 by 300 cm. in area. It was fumigated for one hour on April 18, 20, and 21, 1914, with 5 parts SO_2 per million parts of air by volume (0.013 gram SO_2 per cubic meter). After the first fumigation the front of the plat was very badly bleached. About 40 to 50 per cent of the total area of the leaves had the "concentrated"

type of bleach extending back from the tips. The far end had more of the "mottled" type of injury. In the fumigations of April 20 and 21 the mixture was blown in at the opposite end. Thus the bleach was equalized throughout the length of the plat. About 50 per cent of the foliage throughout the whole plat was badly bleached, as shown in Plate XI, *B*, and Plate XVIII, *A*.

The bleached leaves of this plat were in evidence for a long time. In fact, to the very end of the season the signs of the injury could be found readily. However, the plants continued to develop. The new leaves came out quickly and the heads developed normally. By the middle of May, except for the abnormal number of dried-up basal leaves, the plants appeared to be developing in the ordinary manner. The height of the grain at the end of the season was less than that in the check plat. The heads, however, seemed as large and as well developed as in the check.

This plat was cut on June 26, as was also the check. The area cut was 61 by 457 cm., or 2.79 square meters, through the center of the plat. The check plat received no fumigation.

PLATS 58, 59, 60, AND 61.

The area of these plats was each 121 by 305 cm., or 3.7 square meters. While these plats were being fumigated, the air and sulphur dioxide mixture was blown in at both ends of the cabinet and allowed to escape through the center at the top. The object in fumigating in this manner was to keep the air in complete circulation through the cabinet and to keep the temperature and humidity conditions the same as those of the outside air.

The total volume blown into the cabinet per minute was 8 cubic meters. All plots were fumigated with a concentration of 5 parts SO_2 per million parts of air, by volume (0.0131 gram SO_2 per cubic meter). Each plat, however, was fumigated under different conditions and slightly different results were obtained. The plants were about 50 cm. to 60 cm. high at this time and the heads were coming out.

Plat 58.—Plat 58 received 1-hour fumigations on April 28 and May 1 in the direct sunlight with 5 parts SO_2 per million. The average temperature in the hood was 33° C., and the average humidity was 30 per cent. The average temperature of the outside air was 26° C.

Notes.

April 29.—Very severe bleach is evident throughout the plat. Older leaves are worse than the new. Sheath and head are not affected.

May 3.—About 40 per cent of all foliage is bleached and injured. Very little damage done to sheath or head. General "concentrated" type of bleach shown, although there is some "mottling" evident.

May 11.—General injury showing all over plat, except on the youngest leaves and heads.

The remains of the damage were evident until the end of the season. At end of May was most evident by abnormal number of dried up, white leaves around the base of plants.

Plat was cut June 26, 1914.

PLAT 59.

This plat was fumigated in two 1-hour periods, April 28 and May 1. During the fumigations the hood was shaded by a burlap screen. The average temperature in the hood was 24° C. and the average humidity 60 per cent. The temperature of the outside air was 24° C.

Notes.

April 28.—Very severe bleach was produced throughout the whole plat, worse than in plat 58. The older leaves were more severely damaged than the new.

May 3.—About 50 per cent of all the foliage is bleached and injured. Practically all damage was done to older leaves. The "concentrated" type of injury prevailed. Notes after May 3 are the same as on plat 58. The plat was not cut because plants were too uneven and it was not possible to get good check plat for No. 59.

PLAT 60.

Between April 28 and May 2 this plat was subjected, under shade to twenty-four 5-minute fumigations of 5 parts SO_2 per million. The time between each fumigation was at least 30 minutes, during which time the cabinet was removed from the plat. The average temperature of the mixture blown into the hood was 22° C., and the average temperature in the cabinet was 23° C. The relative humidity in the cabinet was not accurately measured, but due to the short time that the cabinet was over the plat, it was undoubtedly not much different from that of the outside air, which averaged 40 per cent.

Notes.

April 28.—After the fourth fumigation on this date a slight "mottling" appeared on some of the older leaves.

May 1.—"Mottled" areas increased and some of the "concentrated" type of bleach also appeared along the tips.

May 3.—A general bleach throughout the whole plat. Some "mottling" still remains, but the general bleach is of the "concentrated" type, extending back from the tips. The appearance now is about the same as plat 59. Notes after May 3 are similar to those applying to plat 58. The injured leaves were evident to the end of the growth, yet new leaves developed and the head matured normally after the fumigations stopped.

PLAT 61.

Between April 28 and May 3 this plat received sixty 2-minute fumigations in the shade. The total fumigation time was 120 minutes. (See Pl. XVIII, *B.*) The time between fumigations varied between 2 minutes and 20 hours. Owing to the short time that the cabinet was placed over the plat the difference in temperature between the outside and the inside of the cabinet was so slight as to be negligible, especially as the air was being blown in at both ends. Hygrodeik readings in the 2-minute intervals showed very

A. GRAIN IN PLAT 46, APRIL 26, 1914, FIVE DAYS AFTER THIRD AND LAST FUMIGATION.

B. GRAIN IN PLAT 61, MAY 7, 1914, AFTER SIXTY 2-MINUTE FUMIGATIONS OF 5 PARTS SO_2 PER MILLION PARTS OF AIR.

slight differences. Thus the average temperature, 21° C., and the average humidity, 45 per cent, may be taken as the average conditions inside the cabinet.

Notes.

April 28.—At the end of the twentieth fumigation the plants were showing marked signs of damage. First signs of damage were not noted. No fumigation on April 29.

April 30.—Very general "mottling" all over the plat and some of the "concentrated" bleach also present.

May 2 and May 3.—As the fumigations continued, the "mottled" type of injury gave place partly to the "concentrated" type, bleaching solidly back from the tips. The older leaves were most affected. Very little damage to the sheath and practically no visible damage to the head. Ultimate bleach about same as No. 59.

May 11.—Some "mottling" still appeared, though general appearances more the "concentrated" type.

The effects of the fumigations were evident until the end of the growing season, and during the latter stage caused an abnormal number of dried-up white leaves around the base of the plants. The plants in this plat were more scattered than in plats 58 or 60 or the check plat, but they were cut for quantitative purposes on June 26.

Results of experiments in Series 1b, Vallejo.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	2.79	1,728	554	481	87	632
46	2.79	1,415	586	497	85	671
Check	2.23	1,687	553	528	96	820
58	1.67	1,332	473	445	94	572
60	1.67	880	336	310	92	381
61	1.67	880	326	285	87	428

NOTE.—Basing comparative grain yield of plat 61 and check on the yield per unit total head, the yield from plat 61 was 88 per cent of the check.

EXPERIMENTS IN SERIES 1c.

In this series are the plats that received one or two strong fumigations of sulphur dioxide during the period when the grain was filling out in the head. As in series 1*b*, this subdivision includes only plats fumigated at the time for quantitative purposes and does not include plats fumigated only for the purpose of studying the susceptibility of the grain to sulphur dioxide under various conditions. Thus in this series are plats 83 and its check, 84*a*, and plats 98 and 100 and their check, 97.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

VISIBLE INJURY PRODUCED.

One-hour fumigations with 5 or 6 parts per million at this stage of growth produced very marked bleaching on all the foliage. A fumigation lasting two and one-half hours was very destructive, bleaching about 70 per cent of all the foliage. The total leaf area

bleached for any fumigation was greater at this stage than earlier in the season, though the proportion to the total was slightly less, No indications were noted that at this time the plants were materially less susceptible than earlier in the season. The beards were severely burned but no injury appeared in the heads. One plat suffered only an ordinary bleach and the other two suffered very strong bleaches.

EFFECT OF FUMIGATION ON YIELD.

Although these fumigations affected the total weight of the "straw and heads" to some extent, the greatest effect was noted in the weight of the "grain" itself. The hour fumigations of 5 parts SO_2 per million cut down the yield 20 per cent. The fumigation of 2½ hours with 6 parts SO_2 per million reduced the "grain" yield 30 per cent. The indications were that some of the kernels were actually killed and the rest were not fully developed. The fact that the plants matured grain after sustaining the severe bleach while the kernels were just beginning to form is rather astonishing. The indications from this series are that the fumigation prevented many heads from becoming moldy. Thus, although the fumigations undoubtedly reduced the size and number of the kernels in the heads, yet, by killing the mold to a certain extent, the net yield was more nearly that of the check. In a field where there was no mold this advantage of killing the mold would not be gained, and the logical basis for comparison is, therefore, the yield per unit "good head."

Summary of results of experiments in series 1c, Vallejo.

[Fumigations made when plants were headed and the grain filling out—fumigation caused severe injury.]

Plat No.	Concentration of SO_2.		Length of each fumigation.	Number of fumigations.	Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.				Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
			Hours.			*Grams.*	*Grams.*	*Grams.*		*Per ct.*	*Per ct.*
Check	0.0	0	1	1	230	3.25	1.67	4.63	36	100	100
83	5.5	.0142	1	1	258	2.65	1.33	4.49	30	82	80
Check					211	2.96	1.79	4.88	37	100	100
			Mins.								
98	6.0	.0156	20	1	213	2.95	1.48	4.84	31	100	83
100	6.0	.0156	150	1	216	2.53	1.26	4.10	31	85	70

NOTE.—Basing relative yield of grain on yield per unit "total heads," the yield was as follows: Check, 100 per cent; plat 83, 86 per cent; check, 100 per cent; plat 98, 99 per cent; plat 100, 85 per cent.

PLAT 83.

Approximate average height of plants; grain headed and in "milk."
Date of fumigation, May 18, 1914.
Time of fumigation, 1 hour.
Volume of air through cabinet, 4.2 cubic meters per minute.

Volume of SO_2 added, 23 c. c. per minute.

Calculated concentration, 5.5 parts SO_2 per million by volume (0.0144 gram per cubic meter).

Cabinet temperature, average, 24° C.

Relative humidity in cabinet, average, 40 per cent.

Notes.

May 19.—About 40 to 50 per cent of all foliage bleached and injured. All leaves injured more or less, but older leaves most. Portions of beards on the heads are burned. Except for bleached ends of beards, no visible damage done to heads. This injury was visible on the plants until the very end of the season. An abnormal number of dried basal leaves were present before the whole plant started to dry up. The fumigated plat matured at the same time as its check and was cut on June 26.

Area 121 by 305 cubic meters=3.7 square meters.

PLAT 96.

Approximate average height of plants; heads filling out; grain in "milk."

Date of fumigation, May 23, 1914.

Time of fumigation, 20 minutes.

Volume of air through cabinet, 4.2 cubic meters per minute.

Volume of SO_2 added to air, 25.2 c. c.

Calculated concentration, 6 parts SO_2 per million by volume (0.0156 gram per cubic meter).

Cabinet temperature—average at inlet, 20° C.; average at outlet, 22° C.

Cabinet relative humidity—average at inlet, 92 per cent; average at outlet, 96 per cent.

Notes.

Before fumigation it had been raining. Thus the plants were wet.

May 24.—The leaves and beards were badly injured (about 20 per cent of the area bleached). Some of the characteristic sulphur dioxide "blotches" were present where water had stood in the plants at the time of fumigation. General bleach, however, was the "concentrated" type. The heads themselves were not injured. This plat showed injury the rest of the season.

The plat was cut June 26.

Area, 3.7 square meters.

PLAT 100.

Approximate average height of plants; heads filling out; grain in "milk."

Date of fumigation, May 23, 1914.

Time of fumigation, 150 minutes.

Volume of air through cabinet, 4.2 cubic meters per minute.

Volume SO_2 added to the air, 25.2 c. c.

Calculated concentration, 6 parts SO_2 per million by volume, 0.0156 gram per cubic meter.

Cabinet temperature—average at inlet, 19° C.; average at outlet, 21° C.

Cabinet relative humidity—average at inlet, 90 per cent; average at outlet, 85 per cent.

Notes.

Grain wet.

May 24.—The plants are bleached and burned very severely. All injury of the "concentrated" type, and about two-thirds of the total foliage affected. The beards are all bleached close to the heads. No bleach apparent on the heads or the culms close up to the heads. An extremely severe burn.

June 2.—The plants appear about as on May 24. Heads appear, however, to be developing about as normal. No heads are killed. The plants in the plot showed the extensive injury up to the time the whole plant began to dry up.

PLAT 97.

Plat 97 was taken as a check for the above plats 98 and 100. This plat was under a hood for two hours on May 23. No injury of any kind appeared on the plants. The only markings present on the leaves were those caused by the rust or bacterial disease.

Results of experiments in series 1c, Vallejo.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	1.4	1,047	322	270	84	452
83	1.4	960	363	330	91	429
Check	1.4	880	295	231	78	413
98	2.8	1,756	596	558	94	824
100	1.4	766	303	283	93	358

Due to the large proportion of good heads to the total, in the case of the fumigated plats, the relative yield of the grain figured on the yield per unit total heads gives as follows:

Plat.	Yield per unit "total head," per cent.
Check	100
83	86
Check	100
98	99
100	85

EXPERIMENTS IN SERIES 2.

Series 2 comprises plats Nos. 14, 15, 16, 17, and 18, with check plat 19.

These plats were given 10-minute fumigations on 71 days between March 26 and June 13, as follows:

Date.	Number of fumigations.
Mar. 26	1
27	5
28	6
31	2
Apr. 1	4
2	3
3	3
5	3

Then one fumigation was given every day, except on April 9 and 26, May 23, 24, and 31, and June 7. Thus, the total number of fumigations (90) equaled a total of 900 minutes, or 15 hours per plat. Each plat received an average of 52 fumigations in the direct sunlight, 20 in shade—that is, under cloudy conditions—and 18 in partly cloudy weather.

During the first few days several of the plats were fumigated while there was some moisture present on the leaves. However, after the first few days no fumigations were made on these plats until the foliage was dry.

Plats 14, 15, 16, 17, and 18 were fumigated with mixtures of 1 2, 3, 4, and 5 parts SO_2 per million of air by volume, respectively. The average temperature of the air at the inlet was 24° C. At the end of the 10-minute periods the average maximum temperature at the far end of the cabinet was 31° C. The maximum temperature at the outlet end was 47° C; minimum 15° C. The average relative humidity of the air being blown into the cabinet was 55 per cent, which was 1 per cent greater than the average relative humidity at the outlet. The maximum relative humidity on March 28 was 95 per cent. At the time of the maximum temperatures the relative humidity was low, averaging about 30 per cent.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

The 10-minute fumigations with 2, 3, 4, and 5 parts sulphur dioxide per million served to keep the grain more or less badly bleached through the whole season. Repeated 10-minute fumigations throughout the growing season were very effective in reducing the yield of the crop on all plats except No. 14. This plat, which was fumigated with only 1 part SO_2 per million, showed only occasional and very slight signs of injury throughout the season, and in the end yielded practically the same as did the check plat. (See Pl. XIX, *A*.) This fact indicates that no "invisible" injury affected the yield of the grain. All other plats showed visible injury, increasing in extent from plat 15 to plat 18. These plats gave a decided decrease in yield, the yield from No. 18 which received concentrations of 5 parts SO_2 per million being less than 60 per cent of the check. This is a greater yield from No. 18 than was forecasted in May, when the foliage was so badly bleached and the culms so much shorter than the normal grain. Not only were the number of kernels of grains in the heads reduced, but also the weight of the individual kernels was reduced to a great extent. In this series it was noted that the fumigated plats had a fewer number of moldy heads than the check.

Summary of results of experiments in series 2, Vallejo.

[Fumigated 90 times between Mar. 28 and June 13, in 10-minute periods.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Check			212	2.43	1.28	4.15	31	100	100
14	1	0.0026	251	2.42	1.24	3.94	31	100	97
15	2	.0052	195	2.17	1.05	3.88	27	89	82
16	3	.0078	174	1.84	.83	3.63	23	76	65
17	4	.0104	168	1.79	.86	3.42	25	74	67
18	5	.0130	167	1.45	.70	3.53	20	60	55

Detailed notes of plats.

March 28 (after sixth fumigation).—In the morning before fumigations of the day were started. No injury of any character on plats 14, 15, 16, and 17. Plat 18 is slightly faded and shows incipient "mottling" on some of the older leaves.

March 30 (after 12 fumigations).—Plat 14 shows no leaf markings.

Plat 15 shows no leaf markings.

Plat 16 shows fine "mottling" appearing on the oldest leaves.

Plat 17 shows considerable "mottling," general on the plat—the oldest leaves most affected.

Plat 18.—About 20 per cent of the leaves are "mottled." Some slight bleaching back from the tips.

April 2 (after 18 fumigations).—Plat 14 shows no leaf injury.

Plat 15 shows very incipient injury of the "mottled" type of bleach.

Plat 16 shows an increase of "mottled" area over that shown on March 30. Now about 40 per cent of the leaves affected and total area bleached about 15 per cent.

Plat 17 shows about twice as much injury as does No. 16. General injury, the fine white "mottling," but in some cases the "mottled" areas are merged into a general yellowish white bleach. About four-fifths of all leaves affected, and the bleached area equals about 25 per cent.

Plat 18 shows even more injury than does No. 17. The merging of the fine white "mottles" into a general yellowish white bleach has proceeded further than in No. 17. Greatest injury found in the oldest leaves and out near tip of all leaves. Practically all leaves affected. Area bleached is about 35 to 40 per cent of the total foliage.

April 7 (after 27th fumigation).—All plats show an increase in extent of injury. Even No. 14 is starting to show fine white "mottles" on some of the older leaves. On Nos. 17 and 18 the fine "mottling" has given place pretty generally to the white "concentrated" type of injury.

As it was decided that this treatment was too severe for getting the desired data, the fumigations were given only once each day after this date.

April 14 (36 fumigations).—Plat 14 shows a very small amount of the fine white "mottling." Also many yellowish-white leaves. The discoloration on these leaves, however, does not resemble sulphur-dioxide injury.

A. PLAT 17, APRIL 21, 1914, AFTER 42 FUMIGATIONS.

B. PLAT 15, APRIL 21, 1914, AFTER 42 FUMIGATIONS.

C. PLAT 14, APRIL 21, 1914, AFTER 42 FUMIGATIONS.

Plat 15.—The fine white or yellowish white "mottling" is more marked. Some of the leaves almost quite discolored to yellowish white, yet not like sulphur-dioxide injury.

Plat 16.—"Mottling" is slightly greater than in plat 15; also shows many yellowish-white areas on leaves.

Plat 17.—Undoubtedly severe sulphur-dioxide injury. Many leaves bleached back for considerable distance from the tips. Very little "mottling"—mostly all the "concentrated" type of injury. About 35 per cent of area bleached.

Plat 18.—About 40 per cent of foliage bleached killed back. "Concentrated" type of injury.

April 21 (42 fumigations).—Plat 14.—Believe that No. 14 is sustaining some injury, though the leaf markings are not the marks of characteristic sulphur-dioxide bleach, except for a few fine white "mottles." The front of the plat has thinner and lower stand than has the back. Undoubtedly due to natural causes.

Plat 15.—More characteristic sulphur-dioxide markings on this plat than on No. 14. (See Pl. XIX, *B*.)

Plat 16.—This plat very similar in appearance to plat 15. Both have undoubtedly sulphur-dioxide injury and at the same time an abnormal yellowish white bleach over many leaves which does not resemble sulphur-dioxide injury.

Plat 17.—This plat shows very severe bleaching that is unquestionably caused by sulphur dioxide. The tips of the leaves are bleached back for about one-fourth of the length. Practically all injury is the "concentrated" type. The oldest leaves, as usual, are the most affected. (See Pl. XIX, *C*, and Pl. XX, *B*.)

Plat 18.—Very severe bleaching all over the plat, especially in the front. About 50 per cent of foliage bleached, the "concentrated" type. None of the "mottled" type of injury apparent. (See Pl. XX, *A*.)

Comparison of unfumigated plants in check plat and fumigated plants in plat 16 is shown in Plate XVII, *B*, and Plate XXI, *A*.

April 21.—In all the plats the injury is greatest at the intake end. For example plat 17 at the rear end looks about the same as does No. 16 in front. Plat 18 at the rear end is slightly less injured than the front of plat 17. As explained in the general discussion of the work, the cause for the difference in the injury sustained in the front and back of the plats is due to the partial absorption of the sulphur dioxide from the mixture passing through the cabinets. In April, many analyses were made of the air in the cabinets during the fumigations. At the far end, the concentrations were generally only about 75 per cent of the concentration at the intake.

May 1 (51 fumigations).—All plats show about the same relative amount of damage, as has been evident for the last two weeks. Except for an abnormal number of yellowish white leaves around the base of plants, plat 14 seems to be normal and growing as plat 19, the check. The visible damage to the plats increases from plats 15 to 18, and in all plats is greatest at the front end. All plats have a shorter stand in the front than in the back. In no case are the plants killed, although in plats 17 and 18 some of the stalks are extremely small as compared with the normal plants.

May 11.—Plat 14.—About 20 to 25 per cent of foliage dried up and injured, due to all causes. Remaining green leaves high and fully developed.

Plat 15.—About 30 to 35 per cent of foliage dried up. Plants about as high as check except in front.

Plat. 16.—About 40 to 45 per cent of foliage dried up and part of injury undoubtedly due to sulphur dioxide.

Plat 17.—Ratio of dried up and injured foliage to total about the same as in No. 16.

Plat 18.—About 50 to 60 per cent of total vegetation injured.

Plats 16, 17, and 18 are undoubtedly behind the check plats in development. Plat 18 is at least two weeks behind.

Plat 19 (check plat).—Up to the present time this plat has shown practically no injury or yellowing of the leaves. At this time some yellowing appears, which is undoubtedly due to a bacterial disease. At this date the grain in plat 19 is heading out, as are the plants in plats 14 and 15.

May 18.—The plats have about the same relative growth as on May 11. Plats 14 and 15 are heading out very well. Plat 16 is slightly behind the check plat. Plats 17 and 18 are decidedly behind plat 19. The heads in the front of plat 17 and plat 18 are very small. The number of dead leaves around the base of the plants is increasing. The top two or three leaves are the greenest. In plats 17 and 18 these top leaves show some signs of damage. No bleach or drying up noted in the heads themselves.

May 29.—Plat 14.—The grain in this plat is normal in size and general appearance. The height of the plants throughout the length of the plat seems to be nearly equal.

Plat 15.—The first half of the plat is lower and thinner than the back. The upper leaves show some slight markings resembling sulphur dioxide injury. Last half of plat looks normal and as high as check.

Plat 16.—The leaves that are still green show some sulphur dioxide bleaching. The heads do not show any injury but are shorter and less developed than in the check plat.

Plat 17.—This plat is slightly worse than No. 16, especially in the front half. The leaves that are yet green show sulphur dioxide markings. Heads untouched but are shorter and not developed.

Plat 18.—In this plat some of the heads are still in the sheath. Plants are very short. All of the few green leaves in the plat show sulphur dioxide injury, principally the "mottled" type. The few heads developed, beyond the fact that they are very short, show no signs of injury.

June 13.—At this time nearly all the foliage on the plats, as over the whole field, was dried up. The heads were fully developed and the grain starting to harden. Plats 14, 15, and 16 were about as well developed as the check plat. Plats 17 and 18, however, were behind the others, the heads being still green, as were many of the stems. As all the grain was beginning to harden, it was decided to stop fumigation and allow the grain to ripen.

June 26.—At this time plats 14, 15, 16, and 19, the check, were ready to cut.

Plat 14.—Grain appears perfectly normal. Straw is taller than the neighboring untreated grain.

Plat 15.—Grain appears almost normal, especially at the rear end. Heads not so well filled out.

Plat 16.—Decided difference in appearance of heads between plat 16 and check. Smaller heads and lighter grain.

Plat 17.—Not quite ready to cut, although most of the heads are ripe.

Plat 18.—This grain is the worst looking in the whole field. The stalks are short and the heads small. Grain not ripe.

It was decided to leave the plats uncut until plat 18 was ripe. These plats were cut on July 2, at which time plats 17 and 18 were ripe. During the time June 13 to July 2, when the grain was allowed to grow without undergoing fumigation, the plants in plats 17 and 18 showed signs of recuperation. It is believed that had the fumigations continued until late in June the yield for these plats would have been even less than was obtained.

Area sampled from each plat was 2.8 square meters.

A. PLAT 18, APRIL 21, 1914, AFTER 42 FUMIGATIONS.

B. TYPICAL PLANTS IN PLAT 17, APRIL 21, 1914, AFTER FORTY-TWO 10-MINUTE FUMIGATIONS.

A. UNFUMIGATED PLANTS, APRIL 27, 1914, FROM CHECK FOR PLATS 14 TO 18.

B. SPECIAL FUMIGATION CABINET.

Results of experiments in series 2, Vallejo.

[Ninety 10-minute fumigations between Mar. 28 and June 13.]

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	2.8	1,446	894	492	55	630
14	2.8	1,701	702	637	91	794
15	2.8	1,187	547	495	91	523
16	2.8	894	486	455	94	377
17	2.8	849	472	442	94	378
18	2.8	681	468	433	92	301

The relative yield of grain based on weight of gra n per unit total heads is as fol ows:

Plat.	Per cent.
Check	100
14	107
15	100
16	78
17	79
18	66

EXPERIMENTS IN SERIES 3.

This series consisted of plats 31 to 35, inclus.ve, with their checks. These plats were given 186 fum gations of five m nutes' duration each on 61 of the 73 days between April 1 and June 12, inclusive. The average number of fumigations per "fumigation day" was three, the maximum our. The average temperature of the inlet was 24° C. and of the outlet 29° C. The average relative humidity recorded at the far end of the cabinet was about 64 per cent, as against 58 per cent at the inlet. The total time under the cabinet for each plat was 930 minutes, or 15 hours and 30 minutes.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

Repeated 5-minute fumigat ons with concentrations of 3, 4, and 5 parts SO_2 per million parts of air, by volume, were very effective in reducing the yield of the gra n in the plats receiving the treatment. One hundred and eighty-six fumigations of five minutes' duration, w th 4 and 5 parts SO_2 per million reduced the yield to a lower point than did 90 10-minute fumigations. Plat 31 fumigated with only 1 part SO_2 per million, yielded more than he chec . This plat showed only the slightest traces of injury on several occasions dur ng the season. Plat 32, which was fumigated with 2 parts SO_2 per million, showed decided injury to the foliage throughout the whole season. The yield, however, was the same as that of its check. Plat 35,

which received concentration of 5 parts SO_2 per million, gave a yield of only 50 per cent of its check. No evidence to support the theory of "invisible damage" was obtained from this series. In fact, the evidence is all against the probability of "invisible damage." The percentage of moldy heads in the check and fumigated plats was about the same in both.

Plate XXII shows the appearance of the barley after 25 5-minute fumigations.

Summary of results of experiments in Series 3, Vallejo.

[186 fumigations—April 1 to June 12—each of 5-minutes duration.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Check	0	.....	213	2.56	1.30	4.38	30	100	100
31	1	0.0026	186	3.00	1.51	4.31	35	117	115
32	2	.0052	219	2.68	1.28	3.51	36	105	98
33	3	.0078	154	2.04	1.01	3.32	30	86	84
Check	0	.....	198	2.18	1.10	4.29	26	100	100
34	4	.0104	203	1.29	.62	3.22	19	59	56
35	5	.0130	219	1.34	.54	3.21	17	61	49

Notes on plats 31 to 35, inclusive.[a]

April 2.—7 fumigations.

Plats 31 and 32.—No injury.

Plat 33.—Slight sulphur dioxide injury at the front end. Large blotches bleached white where there was moisture on the leaves at the time of fumigation.

Plat 34.—Injury of same character as in plat 33, but over larger proportion of area.

Plat 35.—Shows same bleached areas as plats 33 and 34 and also same mottled areas.

April 8.—22 fumigations.

Plat 31.—Shows no injury whatever.

Plat 32.—Shows very faint traces of the "mottled" type of injury.

Plat 33.—Blotches noted on April 2 still apparent; "mottling" also noted.

Plat 34.—A considerable portion, about 15 per cent, of foliage area affected. Some bleached blotches as noted April 2, but mostly the "mottled" type of injury.

Plat 35.—A considerable increase in the "mottled" area. Some of the "concentrated" type appearing in the solid bleach back from the tips of the leaves.

April 17.—49 fumigations.

Plat 31.—Except for slight yellowing of some of the leaves in the front of the plat, no injury is visible.

Plat 32.—More yellowing of leaves in the front of plat than in 31 and "mottling" also apparent. Plants smaller in back than in front.

Plat 33.—The marking about the same as in 32, only more general. Plants in center of the plat are lower than the average.

Plat 34.—In the front of the plat there is considerable injury of the "concentrated" type. In the last half the injury is practically all the "mottled" type.

[a] See Plates XXIII, *A*, *B*, and *C*, and XXIV, *A*.

BLEACHING OF GRAIN LEAVES BY 25 5-MINUTE FUMIGATIONS WITH DIFFERENT PROPORTIONS OF SULPHUR DIOXIDE.
Sample 1, 2 Parts per Million; Sample 2, 4 Parts per Million; Sample 3, 5 Parts per Million.

Plat 35.—The injury in this plat is greater than in 34. A larger area injured; bleach the "concentrated" type. Only the last few feet of the plat contains the "mottle" type of injury.

April 24.—71 fumigations.

Plat 31.—An increase in the number of yellowish leaves over those existing on April 17.

Plats 32, 33, and 34.—Show about the same amount of sulphur dioxide injury as on the 17th.

Plat 35.—Decidedly worse than on the 17th, more than half the foliage being badly bleached and injured.

May 1.—86 fumigations.

All plats are looking somewhat worse than on previous days. The yellowish leaves in 31 are more than normal, and in this plat there are signs of incipient "mottling." On all plats there are a large number of dried basal leaves.

May 11.—110 fumigations.

Plat 31.—Believe that the abnormal number of yellowish leaves in this plat is due to a great extent to fungi. Yellowing about 10 per cent more than normal. Some tips are "mottled." Very little, if any, characteristic sulphur dioxide injury.

Plat 32.—About one-third of the foliage more or less injured by sulphur dioxide or fungi. A part of this undoubtedly direct sulphur dioxide "mottling." Injury greatest at the inlet end.

Plat 33.—About half of the leaves affected. A great proportion of the injury is due to sulphur dioxide. Smallest plants are near the center of the plat.

Plat 34.—About two-thirds of the leaves affected. Plants are smaller than 33. Some "mottled" areas, but general bleach except on young leaves is the "concentrated" type.

Plat 35.—No green leaves except at the tops of the culms. About three-quarters of all foliage dried up or discolored. Plants are smaller and heads are not so well developed as in the check.

May 29.—152 fumigations.

Plat 31.—The plants in this plat are as high and well developed as any in the surrounding untreated plats. Has about the same number of fungi discolored leaves as the check plats and other portions of the field. No traces of characteristic sulphur dioxide injury showing.

Plat 32.—The plants in this plat seem about normal. Some signs of sulphur dioxide bleach evident, but the general drying up of the whole plant obscures the sulphur dioxide injury to a great extent.

Plat 33.—Nearly all the leaves are bleached more or less. The plants are shorter than in 31 or 32, but longer than in 34.

Plat 34.—The culms here are quite short. Some of the heads still "in the boot." All foliage is drying up. Old sulphur dioxide injury very evident.

Plat 35.—The culms are shorter even than in 34. Many heads "in the boot." No heads are bleached or injured directly.

June 13.—All foliage is dried up. The heads are practically filled out, except in 34 and 35. These heads are probably as well developed as they will be, and the grain in these heads is doughy. Fumigation stopped and the grain allowed to harden without any further fumigation.

June 26.—The plats were all ripe and ready to cut at this date, so that they were not set back materially. Plat 31*a*, a plat that had never been under a cabinet, was cut as a check for plats 31 and 32. Plat 36, which had been fumigated with air containing no sulphur dioxide, was taken as a check for plats 34 and 35, for the soil condition of plats 34, 35, and 36 was very similar. As a check for plat 33, which had a rather poor stand in the middle of the plat, the average of plats 31*a* and 36 was taken.

For all plats, except 36, a strip (61 by 459 cm.=2.8 square meters) through the center was taken as a sample. Samples from 36 were 62 by 305 cm.=1.9 square meters in area.

Results of experiments in series 3, Vallejo.

[186 fumigations—Apr. 1 to June 12—each of 5-minute duration.]

Plat No.[a]	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check *a*	2.8	1,529	598	531	89	665
31	2.8	1,560	520	455	88	689
32	2.8	1,646	613	569	93	726
33	2.8	880	432	369	86	372
Check *b*	1.9	821	376	328	87	360
34	2.8	735	568	500	88	312
35	2.8	821	613	544	89	296

[a] To obtain the figures on the relative yield from plat 33, the average of the two check plats *a* and *b* was taken as standard.

EXPERIMENTS IN SERIES 4.

The plats included in this series are 37, 38, 39, 40, 41, and 42.

On nine days, between April 6 and 16, these plats were fumigated for a total of 33 times, between two and four times each day. Plat 39 was used as a check plat. Plats 37, 38, 40, 41, and 42 were fumigated with 1, 2, 3, 4, and 5 parts SO_2 per million, respectively.

The length of each fumigation was five minutes. The plats averaged 28 fumigations in the sun, 3 under cloudy conditions, and 2 under partly cloudy conditions. The average temperature of the air at the inlet was 21° C. and at the outlet 26° C., a rise of 5° C. in the travel through the cabinet. The average relative humidity of the air at the inlet was 63 per cent. No regular records were made of the humidity at the outlet end of the cabinet. At the start, April 6, the average height was about 25 cm. The plats were 121 by 610 cm., or 7.4 square meters, in area.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

Comparing the results of series 1 and series 4, it is evident that injuries resulting after twelve 5-minute fumigations were only slightly less than would have been produced by an hour's continuous fumigation of the same concentration. Plat 37, receiving 1 part sulphur dioxide throughout the period, was only slightly affected. Plat 38 was noticeably bleached, the "mottled" type prevailing. Plats 41 and 42 were severely affected. It was noted in all these short-time fumigations that the "mottled" type bleach was the general injury that first appeared. With the stronger doses this was replaced by the "concentrated" or "kill-back" type. The yield of plat 40 was approximately 5 per cent; plat 41, 10 per cent, and plat 42, 15 per

A. GRAIN IN PLAT 33, MAY 4, 1914, AFTER ONE HUNDRED 5-MINUTE FUMIGATIONS WITH 3 PARTS OF SO_2 PER MILLION PARTS OF AIR.

B. GRAIN IN PLAT 32, MAY 14, 1914, AFTER ONE HUNDRED AND FOURTEEN 5-MINUTE FUMIGATIONS. LEFT, UNFUMIGATED CHECK PLANTS; RIGHT, PLANTS IN PLAT 32.

C. GRAIN IN PLAT 34, MAY 14, 1914, AFTER ONE HUNDRED AND FOURTEEN 5-MINUTE FUMIGATIONS. LEFT, UNFUMIGATED CHECK PLANTS; RIGHT, PLANTS IN PLAT 34.

A. GRAIN IN PLAT 35, MAY 14, 1914, AFTER 114 FUMIGATIONS.

B. SPECIAL CABINET FOR FUMIGATION EXPERIMENTS.

C. NEAR VIEW OF FUMIGATION CABINET SHOWN IN PLATE XXI, *B*.

cent less than the yield of the check plat. Plats 37 and 38 gave approximately normal yields as compared with the check. Here again we have evidence that considerable bleaching during the early stages of the growth does not necessarily mean a decreased yield. A slight bleach may mean only a very slight loss, if any at all. No evidence of "invisible" injury affecting the yield was found.

Summary of results of experiments in series 4, Vallejo.

[33 fumigations—Apr. 6 to 16—each of 5-minute duration.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
								Per cent.	*Per cent.*
39 (check)	0	.....	238	3.07	1.68	4.27	39	100	100
37	1	0.0026	300	2.91	1.64	4.31	38	95	98
38	2	.0052	254	3.19	1.63	4.60	35	104	97
40	3	.0078	213	3.00	1.58	4.06	39	98	94
41	4	.0104	209	2.77	1.54	4.01	38	90	92
42	5	.0130	250	2.59	1.39	3.98	35	85	83

Notes.

April 8.—After sixth fumigation.

Plat 42.—Receiving 5 parts SO_2 per million parts of air is showing considerable signs of damage, the "mottled" type of bleach being evident.

Plat 41.—Also showing slight traces of the "mottling," especially on the older leaves.

Plats 37, 38, 39, and 40.—Show no signs of any injury whatever.

No fumigations on April 8 and 9.

April 12.—After 14 fumigations.

Plats 41 and 42.—Both plats are looking much worse than on April 8. In plat 42 much of the "mottled" bleach is turning into the "concentrated" type, bleaching solidly back from the tips of the leaves.

Plat 40.—Starting to show "mottling."

Plats 37, 38, and 39.—These plats are still uninjured and look quite normal.

April 17.—After 33 fumigations.

Plat 37.—No characteristic sulphur dioxide injury apparent. A few scattered yellowish leaves throughout the plat. No "mottling."

Plat 38.—About 15 per cent of the leaves are affected, either yellowish or "mottled." Some few leaves affected at tips.

Plat 39.—A few scattered yellowish leaves. Plants look the same as in the outside field. Perfectly normal, yellowish leaves not caused by fumigations.

Plat 40.—About 30 per cent of leaves affected. All injury the "mottled" type, except for a few isolated leaves "killed back" from the tips. Shows some yellow leaves also.

Plat 41.—Injury greater than in plat 40. About 40 per cent of foliage affected—"mottled" type bleach with a few scattered tips "killed back."

Plat 42.—Injury greater than in plat 41. About 50 per cent of foliage affected. Mostly "mottled" type of injury, some of the white "concentrated" type showing up near the front end of the plat.

Fumigation of these plats now ceased.

May 1.—

Plats 37, 38, and 40.—Show no signs of injury whatever. The plants appear normal and of about the same height as the check plat 39.

Plat 41.—Shows indication of previous injury by slightly abnormal number of dried basal leaves. No injury present in green foliage.

Plat 42.—Shows indication, as does plat 41, of previous injury by abnormal number of dried leaves. No injury whatever in green foliage.

May 18.—No signs of injury in any plats. The growth and development in all plats seem normal.

May 29.—The growth on plat 37 seems especially dense compared with the check and the other plats of this series.

Plats 40 and 41.—Somewhat thinner and smaller than the check.

On no plat is there any sign of previous injury, and the growth is apparently normal.

June 26.—All plats ripe and are cut for quantative results.

Area sampled for each plat 61 by 459 cm., or 2.8 square meters, through the center of the plat.

Results of experiments in series 4, Vallejo.

[33 fumigations—Apr. 6 to 16, 1914—each of 5-minute duration.]

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
39 (check)	2.8	2,041	665	575	86	968
37	2.8	2,436	838	733	87	1,204
38	2.8	2,268	710	618	87	1,005
40	2.8	1,702	568	495	87	732
41	2.8	1,615	583	480	82	741
42	2.8	1,814	700	584	83	814

These experiments were planned and carried out expressly for the purpose of fumigating under natural conditions, while the grain was "in the milk."

EXPERIMENTS IN SERIES 5.

Series 5 consists of plats 69 to 79, inclusive.

Data showing character of experiments in series 5, Vallejo.

Plat.	Parts of SO_2 per million parts of air.	SO_2 per cubic meter.	Number of fumigations.
		Grams.	
69a	Not under cabinet.	.....	.....
69	1.0	0.0026	35
70	2.0	.0052	35
71	0	.....	35
72	3.0	.0078	35
73	4.0	.0104	35
74	5.0	.0132	35
75	0	.....	10
76	2.0	.0052	10
77	4.0	.0104	10
78	6.0	.0156	10
79	8.0	.0208	10

Plats 69 to 74 each received 35 fumigations of two minutes' duration. They were made at 10 or 15 minute intervals for seven times in succession daily for five days—May 6, 7, 8, 10, and 11.

Plats 75 to 79 received only 10 fumigations of two minutes' duration. These were made at 15-minute intervals four times on May 10 and 11, and two times on May 12.

The plats were 61 by 305 cm. in area and thus could be covered by a short cabinet. The plats were shaded during fumigation. The cabinets were placed over the plats only during the 2-minute fumigations. The air and sulphur dioxide mixture was blown in by a fan placed at each end of the cabinet and allowed to escape through the center.

The object in blowing in this larger volume of air was to prevent any rise in temperature or change in humidity of the air around the plants in the cabinet during the fumigation. This object was accomplished. During the 2-minute period that the cabinet was placed over the plats, the rise in temperature was less than 1° C. and the humidity difference could not be determined. Thus it was assumed that the plants were being fumigated under natural conditions. All plants in the cabinet were kept in motion by the air currents. No motionless plants were noted. The total volume of air blown into the cabinet was 8 cubic meters per minute. During the fumigations the average temperature was 21° C. and the humidity 40 per cent.

No appreciable difference in the susceptibility of the plants to sulphur dioxide was noted. In seven 2-minute fumigations, or a total of 14 minutes, a slight mottling was noted on the plants that had been subjected to a concentration of 5 parts SO_2 per million parts of air. In fourteen 2-minute periods the bleach produced by this concentration was about the same as that produced by six 5-minute fumigations on plat 42 on April 7. Twenty-eight 2-minute fumigations produced about the same bleached area as an hour's continuous fumigation on plat 2 on March 20, or plat 46 on April 18, or plat 59 on April 28. The only difference was that by the 2-minute period fumigations the bleach produced was more the "mottled" type and in the hour's continuous fumigation it was more the "concentrated" "kill-back" type. As the "mottled" type developed it became more like the "concentrated" type.

The average yield of 69 and 70, which showed no injury even after the thirty-fifth fumigation, was within 3 per cent of the check. Plat 72, which showed slight injury, gave a yield 8 per cent less than the check. Plats 73 and 74 were quite severely injured at the end of the 35 fumigations, and their yields were 20 per cent less than the check. Plat 79, which received ten 2-minute fumigations with 8 parts SO_2 per million, was injured about as badly as plat 73 and gave a yield 11 per cent less than the check.

In these plats (73, 74, 78, and 79) the yield in the grain was surprisingly large. This was the period of the development of the

grain when it was supposed to be most susceptible to the sulphur dioxide gas. The visible bleach produced by the fumigations was very severe on 74 and 79, and a greater effect in decreasing the yield of the grain was anticipated.

Summary of results of experiments in series 5, Vallejo.

THIRTY-FIVE 2-MINUTE FUMIGATIONS, MAY 6, 7, 8, 10, 11.

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Check	0	.....	261	3.57	1.59	4.28	37	100	100
69	1	0.0026	264	3.29	1.52	4.12	36	92	94
70	2	.0052	268	3.57	1.59	3.86	41	100	100
72	3	.0078	275	3.27	1.48	4.21	35	91	93
73	4	.0104	246	2.86	1.28	4.23	30	80	80
74	5	.0130	223	2.65	1.23	3.90	32	74	78

TEN 2-MINUTE FUMIGATIONS, MAY 10, 11, AND 12.

Check	0	.....	261	3.57	1.59	4.28	37	100	100
76	2	0.0052	275	3.40	1.53	4.45	34	95	96
77	4	.0104	263	3.31	1.52	4.40	34	93	96
78	6	.0156	230	3.00	1.48	4.44	33	84	93
79	8	.0208	202	2.93	1.41	4.30	33	82	89

Notes on plats 69 to 74, inclusive.

May 7.—Morning. Grain headed out "in the milk." After first seven fumigations given on May 6, plats 69, 70, 71, 72, and 73 showed no signs of injury whatever. Plat 74, which had received 5 parts SO_2 per million was slightly affected, the fine "mottling" being apparent.

May 8.—After 14 fumigations.

Plats 69, 70, 71, and 72.—Showed no signs of injury.

Plat 73.—Began to show faint signs of "mottling."

Plat 74.—Was decidedly "mottled."

May 9.—After 21 fumigations.

Plats 69, 70, 71, and 72.—Showed no injury.

Plat 73.—Slight "mottling."

Plat 74.—General "mottling" on the whole plat.

May 11.—After 28 fumigations.

Plats 69, 70, and 71.—No injury.

Plat 72.—Faint signs of "mottling."

Plats 73 and 74.—Show an increase of "mottled" areas.

May 12.—After 35 fumigations.

Plats 69, 70, and 71.—Show no injury.

Plat 72.—Slight sulphur dioxide injury visible. Fine "mottling" and yellowing of the tips of the oldest leaves.

Plat 73.—About 30 per cent of the foliage "mottled" or yellow.

Plat 74.—About half the leaves show yellow and white "mottling." "Concentrated" type bleach on the leaf tips.

May 29.—16 days after last fumigation.

Plats 69, 70, 71, and 72.—Show no signs of injury.

Plat 73.—Shows signs of previous injury by abnormal number of dried basal leaves.

Plat 74.—Previous sulphur dioxide injury still apparent. White "mottled" type of injury.

June 12.—All leaves dried up. Heads only still green. All heads look normal.

June 26.—Cut on this date. Areas cut for samples were each 2.3 square meters.

Notes on plats 75 to 79, inclusive.

All this grain "in the milk."

May 12.—After 10 fumigations.

Plat 75 (the check).—Showed no injury.

Plat 76 (2 parts).—Showed no injury.

Plat 77 (4 parts).—Showed very slight injury of the "mottled" type; noticed only on close examination.

Plat 78 (6 parts).—Showed decided injury of the "mottled" type.

Plat 79 (8 parts).—Very severe injury mostly of the "mottled" type, although some "concentrated" bleaching back from tips also noted. No heads injured.

May 28.—Plats 75, 76, and 77.—Show no injury.

Plats 78 and 79.—Show signs of the previous injury. Plat 79 quite severely injured No heads injured.

June 26.—Cut on this date. Area samples 2.3 square meters.

In the preceding table giving the yield, the yield of the three check plats has been calculated as one and used as an average check for the nine fumigated plats.

Results of experiments in Series 5, Vallejo.

[Two-minute fumigations.]

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
(a)	7.4	6,890	1,930	1,724	89	2,738
69	2.3	1,927	585	518	89	773
70	2.3	2,126	595	517	87	823
72	2.3	2,068	632	574	91	848
73	2.3	1,615	565	519	92	664
74	2.3	1,361	513	418	82	514
76	2.3	2,154	634	543	86	832
77	2.3	1,927	583	495	85	752
78	2.3	1,588	530	455	86	672
79	2.3	1,361	464	418	90	589

a Three check plats considered as one.

EXPERIMENTS IN SERIES 6.

This series comprises those plats which received light fumigations for comparatively long periods during the whole growing season. The series comprises plat 7 and its check, and plats 12 and 21 and their check.

It was the idea at the start of the tests to use the data from these plats to determine the extent of "invisible damage." However, as visible injury became apparent early and continued throughout the season, the "invisible" injury data could not be obtained. These plats were finally used to determine the effect on the yield of very dilute fumigations continued for relatively long periods daily, thereby keeping the plants slightly bleached throughout the whole season.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

Plat 7, which received 198 fumigations of 15 minutes' duration with 2 parts SO_2 per million parts of air by volume, showed considerable bleaching throughout the season, especially during the time when the grain was heading out. The final yield, however, was about the same as the check plats, the total weight of "grain and straw" being somewhat less (11 per cent); the weight of the "grain" itself being somewhat greater (10 per cent) than was obtained in the check plat.

Plat 12 received 181 30-minute fumigations with 1 part SO_2 per million parts of air—total, 90½ hours.

Plat 21 received 97 1-hour fumigations with 1 part SO_2 per million parts of air. Plat 21 was bleached to a far greater extent than was plat 12 throughout the season. The extent of the bleach was somewhat less in both these plats than in plat 7. It was noted that on April 17 the bleach on plat 21 after 47 hours' fumigation in 20 days was only slight as compared with the extensive bleach produced by 43 hours' fumigation on plat 9 in six days, March 20 to 25.

The total yield for plat 12 was practically the same as for the check plat. The yield of grain was 12 per cent less than that for the check. Plat 21 gave a considerably decreased total yield, being about 25 per cent less. The weight of the grain, however, was only 13 per cent less than the check.

The fact that while plats 12 and 21 gave a decreased grain yield and plat 7 gave an apparent increased yield compared with the check is to be explained by the difficulty of securing a suitable blank for plat 7. Undoubtedly the data for plat 12 and plat 21 are more nearly correct than for plat 7. Thus we must conclude that continued bleaching, even though extending not over 20 per cent of the foliage during the entire growing season, did affect the yield to the extent of 10 per cent.

These plats were situated where the soil cracked very badly during the dry season in late April and May.

Summary of investigations in series 6, Vallejo.

[Plats that received light fumigations for comparatively long periods during the whole growing season.]

Plat No.	Concentration of SO_2.		Length of time of fumigation.	Number of fumigations.	Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.				Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
			Minutes.			*Grams.*	*Grams.*	*Grams.*		*Per ct.*	*Per ct.*
Check	.....	.....	.....	.....	242	3.00	0.95	3.57	27	100	100
7	2.0	0.0052	15	198	216	2.68	1.04	3.64	29	89	110
Check	.0	.....	60	97	236	3.00	1.35	3.84	35	100	100
12	1.0	.0026	30	181	216	2.95	1.19	3.92	30	98	88
21	1.0	.0026	60	97	243	2.31	1.17	3.97	29	77	87

Relative yield based on grain per total head.

Plat No.	Per cent.
Check	100
7	111
Check	100
12	95
21	89

PLAT 7.

Fumigations were started on March 23, when the plants were from 8 to 10 cm. high. In the 82 days between March 23 and June 12 the plat was fumigated on 49. The maximum number of consecutive days of fumigation was 15. The maximum number of consecutive days when the plat was not fumigated was five. The plat was not fumigated on rainy days nor at times when the grain was wet with dew.

The total number of fumigations was 198, an average of four fumigations per day. The maximum number of fumigations on one day was seven. Each fumigation lasted 15 minutes and there was at least 30 minutes between fumigations. Of the 198 fumigations, 136 were made with the direct sunlight, 43 under clouds, and 19 with partly cloudy conditions. The average temperature of the air blown into the cabinet was 24° C.; the average at the outlet end of the cabinet was 34° C., or 10° C. higher than the inlet. The average relative humidity at the outlet was 54 per cent, or 6 per cent less than the average humidity of the outside air. The maximum temperature in the cabinet was 49° C. at the outlet end and was obtained under a very bright hot sun. At this time the difference between the inlet and outlet air of the cabinet was 18° C. The humidity recorded at this time was 28 per cent. The minimum temperature recorded of inlet air was 13° C. and of the outlet was 17° C. At the time of the maximum humidity (90 per cent) the temperature was 20° C. The total number of minutes that the plat was fumigated during the season was 2,970, or 49½ hours.

Notes.

March 25.—After 9 fumigations, no injury visible.

March 27.—After 18 fumigations, slight "mottling" of leaves noted, especially on the oldest leaves. Youngest leaves not affected. Occasional coalescing of "mottled" areas to form larger bleached areas.

March 31.—No fumigation March 29 or 30 during rains. The plants apparently recovered quite appreciably, due to rapid growth during the rains. Injury to foliage now less than 10 per cent.

April 3.—After 46 fumigations, the proportion of "mottled" or bleached areas about the same as noted on March 27. Except for the "mottling" the plants appear normal and healthy.

April 6.—No fumigations on April 4 and 5. Total to date, 51. The plants look about the same as on the 3d, perhaps a little better. Only a few scattered leaves are affected.

April 10.—No fumigations on the 8th and 9th. Total to date, 61. Few leaves scattered throughout the plat are bleached and tips of many others slightly affected. Not much change from the condition as noted on the 3d.

April 17.—One hundred and seven fumigations to date. The injury is increasing more rapidly than the growth, especially in the first half of the plat. In this part the injury is becoming the white "concentrated" type. The plants in this portion are smaller in size than in the back, but believe this partly due to natural causes as well as to fumigations. In the rear end of this plat the bleach is more of the "mottled" type, with slight yellowing of the foliage. No fumigations from the afternoon of April 18 to the morning of April 21.

April 21.—The plants have recovered somewhat during the four days of rest from fumigation. Are now about 30 cm. high. Many leaves are yellowish in color, which does not seem characteristic of sulphur dioxide bleach.

May 1.—One hundred and thirty-two fumigations. All the oldest leaves are badly bleached and dried up. The youngest leaves are not affected. Those leaves slightly older show the traces of "mottling." The leaves still older are generally "mottled," the "mottled" areas coalescing to form larger white bleached areas. The grain in No. 7 was not so well developed as in the check.

May 11.—One hundred and forty-five fumigations. About half of the foliage is bleached or yellowish. The yellowing (according to Dr. Blankenship) is due to fungi. The grain has been heading out for several days, but is later than the grain in the check. Appearance about the same as on May 1.

May 29.—One hundred and seventy-four fumigations. Bleaching general all over the plat. Worse at the inlet end than at the outlet. The development of the heads seems to be normal, though the heads are somewhat smaller than in the check plat.

June 12.—One hundred and ninety-five fumigations. All leaves are drying up as in all parts of the field. Heads still green and seem to be about the same size or even larger than in the check. Fumigations stopped and the grain allowed to dry and harden unfumigated.

June 26.—Heads still slightly green. Not ready to cut. The check plat for No. 7 was ripe and ready to cut.

July 2.—Plat 7 ripe and cut on this date.

Owing to the rather uneven growth of the grain in plat 7 it was difficult to select a check. Plat 20 was at first thought to be a suitable check, but in May another check was selected as being more like plat 7. The plants were about as thick on this check plat as on plat 7. A cabinet was never placed over this check. A second check plat was selected for No. 7, in which the grain was as short as in the front of No. 7. This check gave a very much smaller total yield per head, but the yield in grain was the same as the first check plat selected. The data obtained from the first plat was selected for comparison with No. 7.

PLAT 12 AND ITS CHECK, PLAT 20.

On 47 days, during the 79 days between March 25 and June 12, this plat received a total of 181 fumigations of 1 part SO_2 per million parts of air, or 0.0026 gram per cubic meter. These fumigations were 30 minutes in duration and were made from two to four times each "fumigation day."

The average temperature of the air at the inlet was about 22° C., and at the outlet was 37° C., a difference of 15° C. The average humidity at the outlet was 47 per cent or about 8 per cent less than at the inlet. The maximum temperature at the outlet was 49° C., and was recorded on a bright sunny day. At that time the average relative humidity at the outlet was 25 per cent.

One hundred and fifteen fumigations were made in the direct sunlight, 35 in cloudy weather, and 31 in partly cloudy weather. Total fumigation time was 5,430 minutes, or 90½ hours.

Notes.

March 28.—Seventeen fumigations. Only by very close observation could a slight "mottling" be detected. No other injury noted.

March 31.—Seventeen fumigations. None on March 28 or 29 during rains. Very slight "mottling" noted by careful observation.

April 3.—Thirty-two fumigations. On April 1, nine fumigations were given this plat. Slight injury to several leaf tips and some "mottling" evident.

April 10.—Fifty fumigations. "Mottling" on many leaves and some of the tips whitened. Injury less than 5 per cent at most.

April 17.—Eighty-six fumigations. Few leaves yellowish in color throughout the plat. Other leaves show fine white "mottling." No fumigations April 17 to 20.

May 1.—One hundred and thirty-four fumigations. Noticeable sulphur dioxide injury, all the "mottled" type. Many basal leaves dried up. Growth appears normal.

May 11.—One hundred and forty-eight fumigations. Plat shows noticeable sulphur dioxide markings, "mottled" type. Growth normal.

May 29.—One hundred and sixty-six fumigations. Very little injury that looked to be due to sulphur dioxide. Many yellow leaves and other dried-up leaves, but no more than in other parts of the field.

June 13.—One hundred and eighty-one fumigations. All foliage drying up. Heads still green, but look normal and full size. Plants shorter in front than in back. Fumigations ceased.

June 26.—Heads still slightly green and not ready to cut.

July 2.—Grain cut. Area sampled, 2.8 square meters through the center of the plat.

The check used for this plat was No. 20. This plat received the same treatment as No. 21, except that no SO_2 was added. Was under a cabinet for 1-hour periods. The plat selected originally as check for No. 12 was very thin and the grain was poor. Although the plat was cut on June 26, the yield of this check was not used in these calculations.

PLAT 21.

On 46 days, during the 67 days between March 26 and June 1, this plat received 97 fumigations of 1 part SO_2 per million parts of air, or 0.0026 gram per cubic meter. Each fumigation lasted for 1 hour, and they were given about two times a day. The average temperature of the air at the inlet was 24° C. The temperature at the outlet was not recorded regularly and an average figure can not

be given. There is no doubt that on hot, bright, sunny days the temperature at the outlet end of the hood got very high, probably about 49° C., especially near the end of the hour's fumigation. The highest recorded temperature was 47° C. The check plat No. 20 received the same treatment at the same time, except that no SO_2 was added. No marks of any injury appeared on No. 20, until late in the season, when some of the leaves turned yellow, due (according to Dr. Blankinship) to fungi. The same yellow leaves were common all over the field.

Notes.

March 28.—After two fumigations. No injury apparent.

March 31.—After six fumigations. Only slight traces of injury, if any at all.

April 3.—Sixteen fumigations. Many slightly "mottled" leaves evident. No "concentrated" type injury.

April 10.—Twenty-seven fumigations. Injury apparently no greater than on the 3d. Few leaf tops whitened, but general slight injury is the "mottled" type.

April 17.—Forty-seven fumigations. A few leaf tips bleached white, many leaves "mottled." Injury is very slight, however.

May 1.—Seventy-two fumigations. Injury is increasing over the plat. Most of the injury is the "mottling" and yellowing. Some of the bleach does not seem characteristic of sulphur dioxide injury. The plants are higher in front than at the rear. At this time it is apparent that the check plat is higher and has better stand than No. 21.

May 11.—Eighty-two fumigations. Dr. Blankinship identifies some of the yellowing and brownish "mottling" as due to fungi. However, some characteristic sulphur dioxide injury apparent, the "mottled" type being apparent on the whole plat.

May 29.—Ninety-five fumigations. Sulphur dioxide injury shows throughout the plat. Grain does not look so good as in the check plat.

June 5.—Fumigation stopped. All grain is practically dried up. Only head and culm still green.

June 26.—Grain in heads not hardened completely yet, but about as well ripened as the check, No. 20, so both left at this time.

July 2.—Both No. 20 and No. 21 were cut on this date.

Results of experiments in series 6, Vallejo.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	2.8	2,041	679	568	84	542
7	2.8	1,624	606	519	86	530
Check	2.8	1,982	661	553	84	745
12	2.8	1,787	605	541	89	646
21	2.8	1,588	681	589	86	691

EXPERIMENTS IN SERIES 7.

These plats were intended for the determination of "invisible" injury. One plat (No. 26) was fumigated to a very slight "mottled" bleach in 15 days by 29-hour fumigations of 0.5 part SO_2 per million

parts of air by volume. With the initial appearance of the bleach the fumigations were stopped, the idea being to allow the plant to recover before resuming them. However, the bleach apparently continued to develop, giving the characteristic "developed mottle." Dr. Blankinship identified some of this injury as being due to a fungus disease. The slight injury due to sulphur dioxide evidently made the plants more susceptible to fungus disease. Because of this doubt concerning the cause of the "mottled" areas and the slowness with which the plant recovered the fumigations were not resumed. Plat 44 was carried through the season from April 15 consistently as an invisible-damage experiment.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

The yield from plat 26 of total weight of "heads and straw" was 15 per cent less than the check, but the "grain" yield was 6 per cent greater. The yield from plat 44 of total weight of "heads and straw" was 10 per cent greater than the yield from the check plat, and the "grain" yield was the same as that of the check. Both of these plats gave evidence that there was no invisible injury affecting the yield.

Summary of results of experiments in series 7, Vallejo.

Plat No.	Concentration of SO_2.		Length of time of fumigation.	Number of fumigations.	Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.				Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
			Minutes.			*Grams.*	*Grams.*	*Grams.*		*Per ct.*	*Per ct.*
Check	0	.....	60	62	311	3.11	1.55	4.54	34	100	100
44	0.5	0.0013	60	62	344	3.44	1.54	4.39	35	111	99
Check	0	.....	60	28	295	2.95	1.22	3.86	31	100	100
26	0.5	.0013	60	29	252	2.52	1.30	4.12	31	85	106

PLAT 26 AND CHECK PLAT 27.

Fumigations started on March 31 and continued to April 15, during which time the plats received 29 fumigations each, plat 26 receiving 0.5 part sulphur dioxide per million parts of air by volume and plat 27 atmospheric air. The length of time of each fumigation was one hour.

Notes.

April 16.—Slight "mottling" appeared on No. 26. Fumigation ceased.

April 20.—Five days after the last fumigation the "mottled" areas had increased greatly in size. Injury was about 15 per cent of total area. Possibly some of this "mottling" due to fungi, according to Dr. Blankinship.

May 11.—No injury was evident. The plat was not fumigated again, but allowed to grow normally, to determine whether this slight injury affected the yield.

No injury of any kind had been found on No. 27 at any time.

May 29.—Grain in No. 26 looked better than in No. 27, the check.

June 26.—Both plats cut. Area sampled 2.8 square meters in center of plat.

PLAT 44 AND ITS CHECK NO. 43.

Between April 15 and May 1 these plats received 3-hour fumigations. At that time, May 1, a slight sulphur dioxide injury was visible on No. 44. Also there was present a few scattered yellowish leaves. Fumigations were stopped. Between May 12 and June 1, the plats were given 23 fumigations, and between June 1 and June 12 they were given 6. Thus the total number of fumigations was 62. At no time was there any characteristic sulphur dioxide injury present, although there were several times when the slightest injury was suspected. The yellowed fungi-colored leaves were present, perhaps more than in normal untreated grain.

Plat 43 showed no injury during the fumigations and was considered to be a very good check for No. 44.

Both plats were ripe and cut on June 26. Area cut, 2.8 square meters.

Results of experiments in series 7, Vallejo.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportions of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	2.8	1,674	538	473	88	733
44	2.8	1,560	548	457	83	706
Check	2.8	2,467	836	758	91	923
26	2.8	1,728	686	640	93	773

EXPERIMENTS IN SERIES 8.

Series 8 consists of those plats which were fumigated at different stages of the growth to determine the effect of sunlight and shade and temperature and humidity conditions on the susceptibility of the plants to sulphur dioxide. They were not carried through to quantitative results.

The experiments were subdivided as follows:

(*a*) Fumigations made under high humidity conditions.

(*b*) Hour-period fumigations to compare injury under sunlight and shade conditions.

(*c*) Five-minute fumigations in the shade.

(*d*) Comparison 2-minute fumigations in sunlight and shade.

(*e*) Comparison of injury resulting from hour, 5-minute, and 2-minute doses.

FUMIGATIONS MADE UNDER HIGH HUMIDITY CONDITIONS.

In this series are included plats 23, 24, and 25. These plats were fumigated when the barley leaves were wet and the humidity of the air inside and outside the cabinet was high.

PLAT 23.

Grain 10 to 13 cm. high.

Fumigated with 1 part SO_2 per million parts of air in 30-minute periods, as follows:

Results of fumigations with 1 part SO_2 per million parts of air in 30-minute periods, series 8, Vallejo.

Date.	Number of fumigations.	Average in cabinet.		Notes.[a]
		Temperature.	Humidity.	
		°C.	Per cent.	
Mar. 29	1	12	95	No injury.
Mar. 30	6	16	90	Produced noticeable bleaching, white blotches rather than "mottling."
Apr. 4	4	18	92	Added to injury, mostly blotches.
Apr. 8	4	18	96	Added considerable to injury.

[a] The bleaching took place generally in blotches where the drops of water had stood on the plants during the period of fumigation. A surprising amount of injury, about 20 per cent of foliage affected, was produced by 15 30-minute fumigations of 1 part SO_2 per million parts of air, as compared with the results obtained on No. 9, which received 1 part SO_2 per million parts of air for 43 hours.

PLAT 24.

Grain 12 to 15 cm. high.

Fumigated with 2 parts SO_2 per million parts of air in 15-minute periods, as follows:

Results of fumigations with 2 parts of SO_2 per million parts of air in 15-minute periods, series 8, Vallejo.

Date.	Number of fumigations.	Average in cabinet.		Notes.[a]
		Temperature.	Humidity.	
		°C.	Per cent.	
Apr. 4	4	21	97	Slight injury noted.
Apr. 8	4	18	96	Decided bleach.
Apr. 9	4	21	95	About 30 per cent of foliage bleached.

[a] Injury greatest in front portion of the plat. The bleach just appeared in spots where the water had stood on the plants. Some "mottling" appeared also on the 9th in the back part of the plat. A surprising amount of damage was done in 12 15-minute fumigations, as compared with the injury done on plat 8 under lower humidity conditions.

PLAT 25.

Grain 8 to 10 cm. high.

Fumigated with 2 parts SO_2 per million parts of air in 15-minute fumigations. Ten fumigations on March 30 and two fumigations on March 31.

Average temperature in cabinet, 20° C.

Average relative humidity in cabinet, 88 per cent.

Notes.

The first half of the plat was badly injured. The injury generally noted in blotches over irregular areas where the vegetation was wet at the time of fumigation. Many leaf tips bleached back. At the back end, where the concentration of SO_2 was found by analysis to be only about 1 part per million, the injury was of the "mottled" type.

General Notes on Plats 23, 24, and 25.

These fumigations have shown that the grain is especially susceptible to the sulphur dioxide under highly humid conditions. When water is present, it absorbs the SO_2 rapidly and passes it along into the plants, so that moist areas will be bleached when the adjacent dry areas are not. The plants recovered rapidly, as did all plants fumigated at this date. No especial notes were made of the rate of recovery.

HOUR-PERIOD FUMIGATIONS TO COMPARE INJURY UNDER SUNLIGHT AND SHADE CONDITIONS.

The following experimental plats were fumigated to determine whether the barley was more or less susceptible to SO_2 in the hot sunlight than in the shade.

PLATS 45 AND 46.

April 18.—These plats were fumigated at the same time with 5 parts SO_2 per million parts of air by volume for one hour. No. 45 was fumigated in the shade, caused by burlap placed over the cabinet. Temperature, 31° C.; humidity, 50 per cent.

Plat 46 was fumigated in the direct sunlight; average temperature of air, 46° C.; humidity, 40 per cent.

The same volume of air was blown into both and, except for sunshine and shade, the conditions on the two plats were about identical. The injury to plat 46 was decidedly greater than to plat 45, by about 15 to 20 per cent. Plat 46 had a greater proportion of leaves bleached, and the bleach was more largely the "concentrated" type than in plat 45. Plat 46 was fumigated again on the two following days and then allowed to grow to maturity for quantitative purposes. Plat 45 was well recovered and showed no signs of injury by May 17.

PLATS 47 AND 48.

April 18.—These plats were fumigated with 4 parts of SO_2 per million parts of air for one hour—plat 47 in the sun and plat 48 in the shade.

Average temperature in plat 47, 43° C.; humidity, 55 per cent.

Average temperature in plat 48, 29° C.; humidity, 46 per cent.

The injury to plat 47 was greater than the injury to plat 48. Both showed more of the "mottled" type of injury than of the "concentrated," and the bleaching did not develop fully for several days. The injury was about 15 per cent greater in plat 47 than in plat 48. By May 11 practically all signs of this injury had disappeared and the grain appeared normal.

From the preceding experiments, 45, 46, 47, and 48, it is evident that the action of the sulphur dioxide on the plants or the absorption of the gas by them takes place more rapidly in the hot sunlight than in the shade.

FIVE-MINUTE FUMIGATIONS IN THE SHADE.

Because the "shaded" plats 45 and 48 showed relatively less injury than the "sunny" plats 46 and 47, fumigated for one hour under the same conditions, it was decided to fumigate several plats in the shade for short periods.

The cabinet used was 3.05 meters long. The shade was furnished by a burlap screen. The plats so fumigated were 49, 50, and 51, these plats respectively receiving fumigations of 1, 2, and 3 parts of SO_2 per million parts of air by volume.

Six 5-minute fumigations were given to each on April 19, and three on April 20 and 21, or a total of 12.

April 20, morning.—Plat 51, which had received six fumigations of 3 parts of SO_2 per million, began to show fine white "mottling".

Plat 50 showed a slight "mottled" area, but much less than in plat 51.

April 21, afternoon.—The "mottled" areas had increased to a considerable extent on No. 50 and No. 51. No injury showed in No. 49.

The fumigations were stopped, as it was evident that with 5-minute fumigations there was no great difference in the injury produced under the shade than under sunlight, and to continue further would duplicate plats 31 to 35 or 37 to 42.

After the fumigation stopped the bleach continued to develop. The fine "mottling" gave place to the "developed-mottle" type of bleach in longitudinal striations. This must mean that at this stage of growth (plants just beginning to head out) the absorption of sulphur dioxide was very rapid, but the subsequent chemical change in the leaf went on rather slowly. The same phenomenon was noted on plat 26, and was discussed under series 7.

COMPARISON OF RESULTS OF 2-MINUTE FUMIGATIONS IN DIRECT SUNLIGHT AND IN SHADE.

PLATS 52, 53, 54, AND 55.

Between April 20 and April 25 these plats were all given 45 fumigations of two minutes each. These fumigations were made five at time, each alternating with two minutes of fumigation with the atmosphere of the field, containing no determinable amount of sulphur dioxide. Thus in the six days, April 20 to 25, the plats had nine applications of these alternating fumigations, or 90 minutes' total fumigation with sulphur dioxide.

Plats 52 and 54 received fumigations of 3 parts SO_2 per million, No. 52 in the shade, No. 54 in the direct sun. No. 53 and No. 55 received fumigations of 2 parts SO_2 per million, plat 53 being in the

shade and plat 55 in the sun. The plants were about 30 cm. high at this time, not yet headed out.

At the end of the 25th fumigation, or 50 minutes of total fumigation time, the plants in both plats 52 and 54 were "mottled" and there was apparently very little difference in the two plats.

At the end of the 45th fumigation plats 52 and 54 were much "mottled" and some "concentrated" type of injury was apparent. The difference in the extent of the injury between No. 52 and No. 54 was hardly determinable. At the end of the fumigations, plats 53 and 54 showed considerable areas that were "mottled." No "concentrated" type injury showed, however. Very little difference between the two plats 53 and 55 was noted.

In order to see whether fumigations under the same conditions at a later stage of growth would show any marked difference, the same type of fumigations were repeated on the same plats on May 12, 13, and 16. At this time all plats were looking normally healthy and free from injury of any sort, and were well headed out. Five doses—that is, a total of 25 2-minute fumigations—were given. At the end of these fumigations plats 52 and 54 showed considerable injury, the "mottled" type, and plat 53 and plat 55 slight injury. There seemed to be no marked difference in the extent of the injury in the shaded or sunny plats. By May 31 all signs of the injury had disappeared and the grain appeared normal in every way.

The temperature in the sunny plats was only 3° C. higher at the end of the 20-minute fumigation period than the temperature in the shaded plats. The relative humidity average was about the same in both sunny and shady plats. Thus it is evident that with temperature and humidity nearly the same, the susceptibility of the grain to sulphur dioxide gas is not greatly affected by sunlight or shade.

COMPARISON OF INJURY RESULTING FROM HOUR, 5-MINUTE, AND 2-MINUTE FUMIGATIONS.

PLATS 58, 59, 60, AND 61.

The notes on these plats are given in detail under the description of experiments in series 1*b*. From the data on these plats, it is evident that the humidity factor is of greater influence than the sunlight. Plat 58, fumigated in the sunlight with a humidity of 30 per cent, was less injured than plat 59, fumigated in the shade, with a humidity of 60 per cent. After the bleaching had fully developed, the extent of the injury to plat 60 (5-minute periods) and to plat 61 (2-minute periods) was about the same as plat 59, so that the factor of time length of any one fumigation did not seem to make any material difference.

PLATS 62, 63, 64, AND 65.

These plats were fumigated with 4 parts of SO_2 per million parts of air, as follows:

Plat 62 received two 1-hour fumigations on April 29 and May 1, in sunlight. Relative humidity 25 per cent.

Plat 63 received two 1-hour fumigations on April 29 and May 1, in shade. Relative humidity, 50 per cent.

Plat 64 received 24 5-minute fumigations on April 29 and 30 and May 1 and 2, in the shade. Relative humidity, 60 per cent average.

Plat 65 received 60 2-minute fumigations on April 29 and 30, and May 2 and 3. Relative humidity, 50 per cent average in the sun.

May 5.—After bleach fully developed, all plats more or less injured, mostly of the "mottled " type, but many leaves also contained the "concentrated" type. Plat 64 showed the greatest amount of injury. Plats 63 and 65 about the same and less than plat 64, while plat 62 showed the least amount of injury.

These tests confirmed the conclusions previously reached that the humidity conditions were important factors and were of greater influence than sunlight or shade. It was noted in all these plats that no damage had apparently been done to the heads themselves. Due to the irregularity of the plants in these plats, it was thought inadvisable to try to obtain any quantitative data on the yield, so that none of these plats was cut.

PLATS 67 AND 68.

These two plats were fumigated for one hour at the same time on May 4, with 3 parts of SO_2 per million parts of air by volume. Plat 67 was fumigated in the direct sunlight. Temperature 32° C., humidity 34 per cent. Plat 68 was fumigated in the shade. Temperature 21° C., humidity 65 per cent.

Both plats were injured, the "mottled" type of injury being predominant. Plat 68 was injured worse than plat 67, by about 15 to 20 per cent. The results on these plats bear out the conclusions that the humidity is more effective in influencing the injury sustained than sunlight or shade or even temperature.

EXPERIMENTS IN SERIES 9.

This series consists of those plats fumigated to determine the relative injurious effects of sulphur dioxide gas and sulphur trioxide vapor or fume.

It was suggested by some of our visitors, who were connected with the smelting industry, that some of the injury to the barley, which had been attributed to sulphur dioxide gas, was due to the presence

of sulphur trioxide vapor or fume in the cabinets, resulting from the oxidation of a slight amount of the dioxide. To investigate this possibility seemed very necessary, and a series of experiments for that purpose was started early in May when the grain was just beginning to head out.

For the purpose of producing a known quantity of sulphur trioxide, a contact conversion apparatus, as described below, was constructed in the Bureau of Mines laboratory and taken into the field at Vallejo.

DESCRIPTION OF APPARATUS FOR CONVERTING SULPHUR DIOXIDE TO SULPHUR TRIOXIDE.

The apparatus used in converting sulphur dioxide to sulphur trioxide is shown in figure 11.

A porcelain tube 2.5 cm. in diameter was placed in the center of two electrically heated furnaces *b* and *a*, *b* being the preheater, and *a* the conversion furnace. These furnaces were built with asbestos, and were wired with nichrome wire. They were heated from the 110-volt line, rheostats being placed in series to control temperatures. A thermocouple was inserted in *a* and connected with a galvanometer for measuring the temperature. The desired volume of air, measured through a capillary meter, was blown in at one end of the porcelain tube and passed through the preheater. The metered volume of sulphur dioxide was added at the other end of the preheater, the resultant mixture then being passed through the contact mass in the contact or conversion furnace *a* (fig. 11). This contact mass consisted of 10 grams of asbestos wool which contained 4 per cent platinum. The asbestos was platinized by soaking it in a solution of platinum chloride in alcohol and then burning off the alcohol. The air and gas mixture contained between 7 and 10 per cent sulphur dioxide. The temperature of the contact mass was kept between 430° and 450° C.

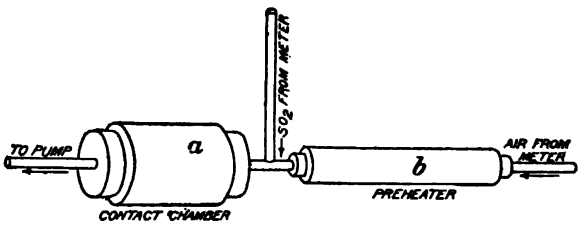

FIGURE 11.—Apparatus for converting SO_2 to SO_3.

A metered volume of sulphur dioxide gas was put through this apparatus and converted to sulphur trioxide. This was added to the intake of the blower and driven into the cabinet in the same manner as in the usual sulphur dioxide fumigations. No baffle box was used, as it was not needed and also because it would cause partial precipitation of the fume. The efficiency of the conversion in all tests was determined by the analysis of the sulphur dioxide in the volume discharged from the blower.

A small and indeterminable amount of the sulphur trioxide was precipitated in the fan and in the delivery pipe, so that the exact weight of the fume discharged into the cabinet per minute was not known. However, a fairly approximate value of the concentration was possible. A very small amount of trioxide in the air produced a visible fume. In cloudy weather the presence of 0.0032 gram per cubic meter (equivalent to the conversion of 1 part of SO_2 per million parts of air) was visible at some distance.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

The experiments in this series prove conclusively that sulphur trioxide fume or vapor was not responsible for any injury found in the plats fumigated with sulphur dioxide. Furthermore, these experiments prove that under dry atmospheric conditions, with the trioxide suspended as "dry fume," the injury that can be produced by a long fumigation with these fumes is slight. In fact, in three hours the fumigation of plants with a very dense fume, namely, 0.026 gram sulphur trioxide per cubic meter, produced no visible injury. That no material injury, visible or invisible, resulted from these long-time fumigations with sulphur trioxide fumes is shown in the yield of the plats 80, 82, and 89, compared with their checks, also plat 96 compared with its check. All of these plats gave yields that were practically the same as their checks. A comparison of the yields from the plats fumigated with sulphur trioxide and those fumigated with sulphur dioxide at the same time is very significant, showing a material decrease in yield from the plots fumigated with SO_2 and no decrease from the plats fumigated with SO_3. It is to be remembered that these fumigations took place during the time the grain was filling out in the head, and thus at the time when the deleterious influence of fumigation on the development of the grain would be a maximum.

Summary of results of experiments in series 9, Vallejo.

[Sulphur trioxide fumigations.]

Plat.	Concentration of SO_3 per cubic meter.	Length of time of fumigation.	Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
				Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
	Gram.	*Hours.*		*Grams.*	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Check	0.000	.....	230	3.25	1.67	4.63	36	100	100
80	.015	2	268	2.97	1.63	4.68	35	91	98
82	.018	1	199	3.26	1.69	4.54	37	100	101
89	.021	2½	201	3.23	1.66	4.64	33	99	100
Check	.000	.....	211	2.96	1.79	4.88	37	100	100
96	.033	1½	218	2.87	1.72	4.22	41	97	96

Relative yield of grain based on total heads.

Plat.	Per cent.
Check	100
80	100
82	100
89	99
Check	100
96	112

Effect on yield of sulphur dioxide and sulphur trioxide fumigations during the period when the heads were filling out.

FUMIGATIONS WITH SULPHUR TRIOXIDE.

Plat.	Weight of SO_3 per cubic meter.	Length of time of fumigation.	Relative yield based on—	
			Straw and heads.	Grain.
	Gram.	*Hours.*	*Per cent.*	*Per cent.*
80	0.015	2	91	98
82	.018	1	100	101
89	.021	2½	99	100
96	.033	1½	97	96

FUMIGATIONS WITH SULPHUR DIOXIDE.

83	[a] 0.014	1	82	80
98	[a] .016	½	100	83
100	[a] .016	2½	85	70

[a] Weight of SO_2 per cubic meter.

PLAT 80.

Fumigated with sulphur trioxide fume.

Date, May 14, 1914.

Time, two hours.

Concentration of SO_3.—19 c. c. SO_2 converted per minute to 0.0616 gram SO_3, added to 4.2 cubic meters air per minute = 0.0147 gram SO_3 per cubic meter. This is equivalent to the conversion of 4.5 parts SO_2 per million parts of air by volume.

Results.—No injury resulted from this fumigation. No bleach appeared on the heads or on the leaves, either directly after the fumigation nor at any time later.

PLATS 82 AND 85.

Fumigated with sulphur trioxide fume.

Date, May 18, 1914.

Time, one hour for plat 82, one-half hour for plat 85.

Concentration of SO_3.—23 c. c. SO_2 converted per minute to 0.0747 gram SO_3, added to 4.2 cubic meters air per minute = 0.0178 gram SO_3 per cubic meter. This is equivalent to the conversion of 5.5 parts of SO_2 per million parts of air by volume.

Results.—No injury or bleach resulted from these fumigations. (Compare these results with those obtained on plat 83 following.)

PLAT 83.

Fumigated with sulphur dioxide gas.
Date, May 18, 1914.
Time, one hour.
Concentration of SO_2.—5.4 parts per million parts of air by volume.
Results.—Very severe injury resulted, about 50 per cent of the foliage being bleached with the "concentrated" type of injury. (Compare results with those obtained on plats 82 and 85 above.)

PLAT 86.

Fumigated with sulphur dioxide gas.
Date, May 19, 1914.
Time, one hour.
Concentration of SO_2.—3 parts per million parts of air by volume.
Results.—Slight injury resulted to the leaves and some of the beards. Mostly the "mottled" type. The results should be compared with those on plats 84, 87, and 88.

PLAT 84.

Fumigated with sulphur trioxide fume.
Date, May 19, 1914.
Time, one hour.
Concentration of SO_3.—11.3 c.c. SO_2 converted per minute to 0.0367 gram SO_3; added to 4.2 cubic meters air per minute = 0.0087 gram SO_3 per cubic meter. This is equivalent to the conversion of 2.7 parts of SO_2 per million parts of air by volume.
Results.—No injury or bleach resulted.

PLAT 87.

Fumigated with sulphur trioxide fume.
Date, May 19, 1914.
Time, one hour.
Concentration of SO_3.—12.6 c. c. SO_2 converted per minute to 0.0410 gram SO_3; added to 4.2 cubic meters of air per minute = 0.0098 gram SO_3 per cubic meter. This is equivalent to the conversion of 3 parts of SO_2 per million parts of air by volume.
Results.—No injury or bleach resulted.

PLAT 88.

Fumigated with sulphur trioxide fume and sulphur dioxide gas.
Date, May 19, 1914.
Time, one hour.
Concentration of SO_3.—12.6 c. c. SO_2 converted per minute to 0.0410 gram SO_3; added to 4.2 cubic meters of air per minute = 0.0098 gram SO_3 per cubic meter. This is equivalent to the conversion of 3 parts of SO_2 per million parts of air by volume.

Concentration of SO_2.—1 part of SO_2 per million parts of air by volume.

Results.—No injury or bleach resulted.

PLAT 89.

Fumigated with sulphur trioxide fume.

Date, May 19, 1914.

Time, two and one-half hours.

Concentration of SO_3.—27.3 c. c. SO_2 converted per minute to 0.0887 gram SO_3; added to 4.2 cubic meters of air per minute = 0.0211 gram SO_3 per cubic meter. This is equivalent to the conversion of 6.5 parts of SO_2 per million parts of air by volume.

Results.—No injury or bleach resulted. The results should be compared with those on plat 90.

PLAT 90.

Fumigated with sulphur dioxide gas.

Date, May 20, 1914.

Time, one-half hour.

Concentration of SO_2.—6.5 parts of SO_2 per million parts of air.

Results.—Injury and bleach produced on the foliage. Some "concentrated" but mostly the "mottled" type.

PLATS 91 AND 93.

Fumigated with sulphur trioxide fume.

Date, May 20, 1914.

Time, three hours for plat 91; one and one-half hours for plat 93.

Concentration of SO_3.—33.6 c. c. SO_2 converted per minute to 0.1100 gram SO_3; added to 4.2 cubic meters of air per minute = 0.026 gram SO_3 per cubic meter. This is equivalent to the conversion of 8 parts of SO_2 per million parts of air by voulme.

Results.—No injury or bleach resulted on either plat. The results on plat 94 should be noted.

PLAT 94.

Fumigated with sulphur dioxide gas.

Date, May 20, 1914.

Time, one-half hour.

Concentration of SO_2.—8 parts per million parts of air.

Results.—This half-hour fumigation with 8 parts of SO_2 per million parts of air produced very severe injury. Most of the foliage was bleached, as were also some of the beards on the heads. The injury was mostly the "concentrated" type. This severe injury is in marked contrast with the absence of injury produced by fumigations with the very dense fumes of SO_3 continued for long periods, as in fumigations on 91 and 93.

PLAT 95.

Fumigated with sulphur dioxide gas.

Date, May 21, 1914.

Time, one-half hour.

Concentration of SO_2.—Ten parts per million parts of air by volume.

Results.—Very severe injury resulted from this fumigation. Most of the injury the "concentrated" type, but some "mottled" type is also evident. Compare with the results obtained on plat 96 below.

PLAT 96.

Fumigated with sulphur trioxide fume.

Date, May 21, 1914.

Time, one and one-half hours.

Concentration of SO_3.—42 c. c. SO_2 converted per minute to 0.1368 gram SO_3; added to 4.2 cubic meters of air per minute = 0.0326 gram SO_3 per cubic meter. This is equivalent to the conversion of 10 parts SO_2 per million parts of air by volume.

Results.—No injury or bleach resulted whatever. Compare with the results obtained on plat 95 above.

PLAT 101.

Fumigated with sulphur dioxide and sulphur trioxide fume.

Date, May 25, 1914.

Time, two hours.

Concentration of SO_2.—0.0026 gram per cubic meter, or 1 part SO_2 per million parts of air.

Concentration of SO_3.—0.0065 gram per cubic meter. This is equivalent to the conversion of 2 parts SO_2 per million parts of air by volume.

Results.—In this plat there were many tall stalks which touched the top of the cabinet. These leaves and stalks and heads touching the cabinet sweated during the fumigations and were moist. After fumigations these moist leaves and heads were spotted and dried up. A characteristic sulphuric acid drying out and burn was noted, which to only a very slight degree resembled the sulphur dioxide bleach. No other leaves or heads affected in the slightest degree.

PLAT 102.

Fumigated with sulphur trioxide fume.

Date, May 25, 1914.

Time, two and one-half hours.

Concentration of SO_3.—0.010 gram SO_3 per cubic meter. This is equivalent to the conversion of 3 parts SO_2 per million parts of air by volume.

Results.—In this plat, as in No. 101, were many tall heads and some leaves which touched the under side of the cabinet top and sweated

in the direct rays of the sun. After the fumigation these contact leaves and heads were shriveled and dried up. No bleach resembling SO_2 injury was evident. Other shorter leaves and heads were not affected in the least. In this fumigation fine dust that had been taken from the Selby roaster bag house was added through the fan, so that it was suspended in the air of the cabinet for some little time. After the fumigation this fine dust was found on the leaves and heads and also on the ground and outside the cabinet where it had escaped. No characteristic spotting of flue dust was noticed after fumigation. This dust was allowed to remain on the plants and no injury or spotting developed between May 25 and June 13, at which time the foliage was quite well dried up, due to maturity.

PLAT 103.

Fumigated with sulphur trioxide fume.

Date, May 26, 1914.

Time, two hours.

Concentration of SO_3.—0.0065 gram SO_3 per cubic meter. Equivalent to the conversion of 2 parts SO_2 per million parts of air by volume. Flue dust also added to blower and blown into the cabinet.

Results.—No injury resulted except to several isolated tall heads that were against celluloid top of cabinet, as noted in Nos. 101 and 102.

PLAT 104.

Date, May 27, 1914.

Time of fumigation, 3 hours.

Concentration of SO_2.—0.0026 gram per cubic meter, 1 part per million parts of air by volume.

Concentration of SO_3.—0.010 gram per cubic meter. Equivalent to the conversion of 3 parts SO_2 per million parts of air by volume. Fume added through the fan. Water also sprayed in on the grain.

Results.—Very slight SO_2 injury resulted where water had stood on plants. No injury to dry leaves.

PLAT 106.

Date, June 3, 1914.

Time, one hour.

Concentration of SO_3.—Unknown, but comparatively very large. Produced by blowing air through fuming Nordhausen acid, the fume being discharged into the fan and blown into the cabinet. A very dense cloud of fume in the cabinet. Not possible to see across because of fume.

Results.—Absolutely no visible injury resulted.

Several experiments were made between May 24 and June 5, Nordhausen acid being used for producing fumes. No data of the concentration of SO_3 in any case were obtained, but in all cases the air over the experimental plats was filled with a dense fume during

periods of time varying between 20 minutes and 2 hours. No visible damage was produced in any case, except in cases where the grain, leaves, or heads were pressed against the celluloid surface of the cabinet top.

The experiments using SO_2 fume were continued later in the laboratory of the Bureau of Mines, and the conditions under which the characteristic SO_2 or H_2SO_4 spotting is produced were determined approximately. This later work will be discussed elsewhere in this report.

Results of experiments in series 9, Vallejo.

Plat No.	Area sampled.	Weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	1.4	1,047	322	270	84	452
80	1.4	1,074	362	310	86	506
82	1.4	906	278	230	83	389
89	1.4	908	281	232	83	386
Check	1.4	880	295	231	78	413
96	1.4	933	305	280	92	481

EXPERIMENTS IN SERIES 10.

FIRST GROUP OF SPECIAL EXPERIMENTS.

The following experiments were conducted to determine the cause for the discrepancy between the results obtained in these experiments by the method of fumigation adopted and the results recorded by the many previous investigators. The method most commonly used by other investigators was that of adding a measured volume of sulphur dioxide to a known volume of air, inside a glass case or house in which the plants under investigation are placed.

Without going into a long discussion of the results obtained by these earlier investigations it is only necessary to state that a concentration of about 10 parts SO_2 per million has been reported to be the limit of dilution that would produce injury. In order to carry out some experiments similar in detail to the "fumigations" of other investigators we obtained a fumigation cabinet that had been constructed by the Balaklala Consolidated Copper Co. for the use of Dr. J. W. Blankinship. As shown in Plate XXIV, *B*, this cabinet was built of wood with glass sides and front. The frame and back were made of oak. The front consisted of two glass doors, hinged at the sides. The capacity of the cabinet was 0.15 cubic meter. In the back was a hole 10 cm. square for the introduction of the dish containing the chemical agents to produce sulphur dioxide.

In the first experiments at Vallejo a mixture was prepared, as in the regular fumigations, by adding a metered volume of sulphur dioxide to the intake of the fan, the volume discharged by the fan

being measured. This mixture was blown into the cabinet, through the hole in the back as it stood on the plat of grain selected, at the rate of about 1.72 cubic meters per minute for two minutes. After two minutes the hole was closed by a slide, and the rate of disappearance of the sulphur dioxide determined by analyses of samples taken from the cabinet at definite intervals.

EXPERIMENT 1, APRIL 2, 1914.

Cabinet placed over two barley plants, each about 25 cm. high. Mixture blown in for two minutes.

Kind of sample.	Parts of SO_2 per million parts of air.
Mixture blown into cabinet	7.0
Air in cabinet 1 minute after the cabinet was closed	2.0
Air in the cabinet 5 minutes after the cabinet was closed	.5
Air in the cabinet 10 minutes after the cabinet was closed	<.2

Believing that there was a possibility of some of the sulphur dioxide being lost by dispersion or diffusion due to very small cracks in the cabinet joints, the joints and corners were well sealed with putty on the outside before starting experiment 2.

EXPERIMENT 2, APRIL 2, 1914.

Kind of sample.	Parts of SO_2 per million parts of air.
Air blown into cabinet	10.0
Air in cabinet after cabinet was closed 1 minute	3.0
Air in cabinet 5 minutes after the cabinet was closed	.4
Air in cabinet 10 minutes after the cabinet was closed	<.2

On April 3 experiments were conducted as follows: The cabinet was sealed with putty except for a small hole in the center of the back where a glass tube was inserted. Through this glass tube was added a definite volume of SO_2 contained in a burette over mercury. A small fan revolving in one corner of the cabinet served to mix the SO_2 with the air. Analyses were made as in experiments 1 and 2 to determine the rate of disappearance of SO_2.

EXPERIMENT 3, APRIL 3, 1914.

The cabinet was placed over a single large plant about 30 cm. high. Fan was revolved to circulate about 1 cubic meter a minute, keeping the foliage of the plant in motion.

SO_2 added 3 c. c., calculated to equal 20 parts SO_2 per million parts of air by volume in the cabinet.

Kind of sample.	Parts of SO_2 per million parts of air.
SO_2 in sample taken one-half minute after SO_2 added	7.0
SO_2 in sample taken 1 minute after SO_2 added	4.2
SO_2 in sample taken 5 minutes after SO_2 added	<.2

Experiments such as the above three were repeated several times with approximately the same results, showing a very rapid disap-

pearance of the SO_2 from the atmosphere in the cabinet. Thus it is evident that in that method of fumigation there is no way of determining the time during which the plant is receiving a fumigation. Momentarily the plant may be in contact with the calculated concentration but the disappearance of the SO_2 is so rapid that the length of time of any fumigation is very small. The disappearance of the SO_2 may be due to a number of causes, namely, absorption by the foilage, absorption by the wood or the soil, or oxidation to SO_3.

In order to eliminate all possibility of leakage through cracks and to cut down the contact of the gas with the wood to a minimum, a glass case was constructed as shown in Plates XXI, *B*, and XXIV, *C*.

The sulphur dioxide was measured over mercury in a burette and passed into the cabinet through one of the glass tubes shown. A fan in the case served to keep the air in circulation to aid the mixing of the gas. Samples of the air were drawn out through the second glass tube. The capacity of the glass case was one cubic meter.

EXPERIMENT 4, APRIL 15, 1914.

Case placed on plants 35 cm. high. Volume of SO_2 added to the case, 25 c. c. Therefore, SO_2 equaled 25 parts per million parts of air by volume.

Kind of sample.	Parts of SO_2 per million parts of air.
Taken 1 minute after adding SO_2	10.0
Taken 5 minutes after adding SO_2	1.2
Taken 10 minutes after adding SO_2	$<$ .2

EXPERIMENT 5, APRIL 17, 1914.

Case placed over plants 35 cm. high. SO_2 added, 200 c. c., 200 parts per million.

Kind of sample.	Parts of SO_2 per million parts of air.
Taken 1 minute after adding SO_2	50.0
Taken 5 minutes after adding SO_2	7.0
Taken 10 minutes after adding SO_2	.5

Experiments were made later to determine the absorption over bare ground with no vegetation present, and the disappearance was found to be rapid, although not so rapid as when vegetation was present. Further experiments made with the glass case placed on paper to prevent absorption by the soil still showed considerable disappearance.

In order to determine whether or not this disappearance was due partly to the oxidation of SO_2 to SO_3, more careful work was required than could be done in the field. The work along these lines was continued in the Bureau of Mines laboratory at San Francisco and will be discussed elsewhere in this report.

The conclusions drawn from these experiments in the field at Vallejo were as follows:

1. Due to the fact that in many of the early investigations no attempt had been made to maintain a definite concentration for any period of time, the number of fumigations was a very indefinite basis for stating results.

2. If a sufficient number of these "fumigations," as applied in the other methods of investigation, had been applied in rapid succession so that the total time that the concentrations were present in the fumigating atmosphere was the same as in the fumigations given in this work, the same results would have been obtained.

SECOND GROUP OF SPECIAL EXPERIMENTS.

The claim had been advanced by several investigators doing work along similar lines that some of the injury in the fumigated plats was not due to sulphur dioxide, but was due to abnormal conditions existing while the plants were under the cabinet. The possibility of this trouble had been anticipated at the first, and every effort had been made to determine how extensive this might prove. As stated above, at no time did the check plats, fumigated with the air containing no determinable amount of sulphur dioxide under the same conditions as the regular fumigated plats, show any signs of bleaching or injury. Even Vallejo plat 10, which received seven hours' fumigation with sulphur dioxide free air in the direct sunlight daily on six successive days, did not show the slightest sign of injury.

Vallejo plats 20, 43, and 27, which received fumigations of hourly duration daily, showed no signs of bleach or other injury. No leaf markings whatever were apparent until early in May when the yellow fungus diseased leaves were present in the check plat as in all parts of the field.

At Davis the same condition was true, that the check plats fumigated showed no signs of bleach or any injury that was not also present on the whole field.

With these facts in view, it was safe to conclude that none of the injury or bleach produced in the fumigated plats was caused by any abnormal condition due to the cabinet being placed above the plants.

However, in order to study the markings or injury that might be brought about by these abnormal conditions when carried to the extreme, the following tests were made:

The glass case described above was placed above plants for varying periods of time, varying from 1 hour to 10 days. As the glass case sat squarely on the ground in most cases there was almost no circulation of air, and the glass surfaces were generally covered with drops of water from the sweating of the plants. Under the direct rays of the sun the temperature in the case was found to be as high as 52° C. However, except in one instance, no bleach resulted. In

this particular instance the plants were exceptionally tall and some of the leaves laid up against the top of the case. Moisture collected there and under the direct rays of the sun, there was produced a white blotched bleaching that was dissimilar to that produced in any of the sulphur dioxide fumigations. The leaves immediately below the contact leaves were wholly unaffected after being in the glass case for 10 successive days. Thus as very extreme treatment under glass failed to produce leaf markings or bleaches similar to that produced in the plats fumigated with sulphur dioxide, we were doubly assured that the injury attributed to sulphur dioxide was not sun scald nor caused by any abnormal conditions existing in the cabinet.

FUMIGATION EXPERIMENTS AT THE UNIVERSITY OF CALIFORNIA FARM AT DAVIS, CAL.

The field of barley selected for the experimental work was plowed 8 inches deep December 1 to 9, 1913, was harrowed on the 9th and again on the 12th of December, and disked 3 inches deep between February 11 and 17, 1914. On February 27 and March 2 it was again harrowed. Between March 2 and 4 Beldi barley was sown by drill and the field was again harrowed on March 5 and 6.

Fumigation work was started on April 10, when the plants were about 25 cm. high and well stooled out. The stand was about twice as thick as at Vallejo, and generally more even. However, there were several spots in the field where water had stood early in April and where the grain was low and uneven. At the time the tests were started no fungi diseases were noted.

All the fumigation work at Davis was done with a single cabinet and meter set (Pl. XXV, *A*). Only a few long-time fumigation experiments were made at this field, and these were made to determine the effect of severe bleaching on the ultimate yield rather than to determine the bleaching effect produced by any definite concentration. As at the Vallejo field, the calculated concentrations were checked from time to time by analyses.

On April 8 and 9 there was a considerable rainfall, so that on May 10, when the fumigations were started, the soil was moist, and in some parts of the field water was standing on the surface.

The plats at Davis (see Pl. XXV, *B*) are grouped under the following series:

Series 1.—Plats that were given one or two strong fumigations of sulphur dioxide, resulting in severe injury, then allowed to grow normally.

Series 2.—Plats that were subjected to fumigations of 10 minutes' duration daily during the season.

Series 3.—Plats that were subjected to an average of about four fumigations each of 5 minutes' duration nearly every day during the season regardless of humidity conditions.

Series 4.—Plats that were fumigated expressly for the purpose of determining "invisible" damage.

Series 5.—Plats that were given 5-minute fumigations at different times under lower humidity conditions than series 3.

Series 6.—Plats that were given 5-minute fumigations in the shade.

Series 7.—Plats that were given fumigations under different sunlight and shade conditions.

Series 8.—Plats fumigated in the open air outside the cabinets. In this series are also included the fumigations made under a cabinet when the air and the gas mixture were distributed throughout the cabinet by pipes.

EXPERIMENTS IN SERIES 1, DAVIS.

Plats 10, 11, and 26 were fumigated to produce a very severe bleach.

SUMMARY OF RESULTS OF EXPERIMENTS.

Plat 10 was fumigated when the plants were about 25 cm. high. Due no doubt to the high humidity, the injury produced was greater than had been produced by a similar fumigation at Vallejo. The effect of this severe bleach was to reduce the yield only slightly, the total weight of "grain and straw" per head being 4 per cent greater than the check and the yield of "grain" per head being 4 per cent less than the check.

Plat 11 was fumigated under low-humidity conditions two weeks later, when the grain was 38 cm. high and the sheath in evidence. This was not so severely bleached as No. 10. The yield from this plat was practically 7 per cent less than the check.

Plat 26 received a very severe bleach during the time the grain was "in the milk." At the front of the plat practically none of the foliage was left unbleached. Even the beards were bleached as far down as the glumes. In the back there was some green foliage left, probably about 30 per cent of the total. Even after this intensely severe bleach and killing of the foliage the plants matured grain, the yield in front being 80 per cent and in the back 81 per cent of the yield of the check.

The results from these plats bear out the results obtained at Vallejo, namely, that one or two severe bleaches in the early stages of the growth do not seriously affect the yield in grain. Fumigations made while the grain was "in the milk" caused a larger decrease, but the maximum decrease of yield was not more than 25 per cent. Some of the kernels were killed outright and others did not mature normally.

A. BARLEY FIELD AND FUMIGATION APPARATUS USED AT DAVIS, CAL.

B. SIZE AND ARRANGEMENT OF EXPERIMENTAL PLATS AT DAVIS, CAL.

Summary of results of experiments in series 1, Davis.

Plat No.	Concentration of SO_2.		Length of time of fumigation.	Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.			Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
			Hours.		*Grams.*	*Grams.*	*Grams.*		*Per ct.*	*Per ct.*
Check	.....	.....	.....	407	2.95	1.19	4.58	26	100	100
10 (front)	5.0	0.0130	1	461	3.08	1.08	4.41	25	104	96
Check	.....	.....	.....	517	3.02	1.14	4.83	24	100	100
11 (front)	3.0–5.0	.0069–.0130	3	567	2.88	1.04	3.94	26	95	91
Check	.....	.....	.....	461	2.80	1.11	4.03	27	100	100
26 (front)	10.0	.0260	1	306	2.72	.63	3.22	20	97	80
26 (back)	5.0	.0130	1	423	2.69	.76	3.49	22	96	87

PLAT 10.

At the time of fumigation the plants in this plat were well stooled out and were about 25 cm. high. The soil was wet from rain of April 8.

Date of fumigation, April 10, 1914.

Time of fumigation, 1 hour.

Volume delivered to cabinet, 3.5 cubic meters per minute.

Volume SO_2 added, 17.5 c. c. per minute.

SO_2 calculated, parts per million, 5 (0.0131 gram per cubic meter).

SO_2 by analysis—at inlet, 4.8, and at outlet, 3.5 parts per million.

Temperature of the air in cabinet—at inlet, 21° C.; at outlet, 29° C.

Humidity of air in cabinet—at inlet, 60 per cent; at outlet, 80 per cent.

Notes.

April 11.—Very severe injury, the "concentrated" type, all over the plat. Many leaves almost completely bleached. About 60 per cent of the foliage affected. Worse injury in front than in back.

April 23.—Plants are growing as normal. Injury still showing over the whole plat. Most blades are white at their tip ends. Plants as high as in the check.

April 29.—Plants have been growing very rapidly. Now about 40 to 45 cm. high. Superficial examination would fail to show any signs of the bleach. Careful examination, however, reveals the presence of the old injury on the tips of the leaves. Also an abnormally large number of dried-up leaves around the base.

May 2.—No signs of bleach visible. Plants appear perfectly normal and as high as the check.

May 15.—In every way the plants in No. 10 look the same as in the check plats.

May 28.—Plat 10 appears normal in size. Heads appear to be filled out as in the check. Grain now starting to ripen.

June 15.—Ripe and cut. The check plat was not fumigated, but was simply staked off and allowed to grow normally.

PLAT 11.

Fumigated, April 26 and 27, 1914.

Height of plants, 35 to 40 cm.

On April 26 received a 1-hour fumigation of 3 parts sulphur dioxide per million parts of air by volume.

On April 27 received 1 hour's fumigation of 3 parts and 1 hour of 5 parts sulphur dioxide per million parts of air by volume.

No record of the temperature or humidity was made during the fumigations.

The injury on this plat developed very slowly; after the "mottled" type appeared, then in 24 hours the "concentrated" type was present.

Notes.

May 2.—Five days after fumigation. The injury was all the "concentrated" type and general all over the plat. About 60 per cent of foliage affected.

May 15.—At this date the injury was almost all outgrown. Now less than 10 per cent of foliage affected. Some of the "mottled" type of injury persists, but the general bleach is the "concentrated" type.

May 28.—No signs of the injury. Plants appear normal in every way.

June 15.—Ripe and cut.

The check for this plat did not receive any fumigations.

PLAT 26.

Fumigated on May 5 for a period of 90 minutes with 10 parts SO_2 per million parts of air by volume. At this time the plants in this plat were from 50 cm. to 60 cm. high, were headed out, and "in the milk." No temperature or humidity records were made during the fumigation.

Notes.

May 5.—Some of the leaves started to droop and wilt even before the cabinet was removed. In three hours after the fumigation the bleach had developed to about its maximum. The injury was extremely severe. In front practically 95 per cent of all foliage was bleached, with the "concentrated" type injury. Even the beards of the heads were bleached back to the glumes. The glumes themselves were not bleached but remained green. The back portion of the plat was not so badly affected as was the front, probably 60 per cent being bleached.

May 15.—The heads appear to be developing about as normally, though they are somewhat smaller than in the check plat. The foliage is not recovering.

May 28.—The heads are developing, but are undoubtedly smaller than in the check. The dried leaves in the plat are badly infected with a fungus disease, much worse than the check plat.

June 15.—Ripe and cut.

Two samples were taken. One from the front of the plat and one from the back end where the injury of May 5 was not as great as in the front.

Results of experiments in series 1, Davis.

[Strong fumigations of SO_2 and intense bleaching.]

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	1.12	1,341	456	442	97	527
10 (front)	1.12	1,588	516	500	97	542
Check	1.67	2,609	865	845	98	967
11 (front)	1.67	2,722	946	935	99	971
Check	1.12	1,446	516	502	97	560
26 (front)	1.12	933	343	338	98	213
26 (back)	1.12	1,272	473	470	99	358

EXPERIMENTS IN SERIES 2.

PLATS 1, 2, AND 3, WITH CHECK.

On 53 days of the 65 between April 10 and June 13, inclusive, each of these plats received one fumigation of 10 minutes' duration. Plats 1, 2, and 3 were fumigated, respectively, with concentrations of 5, 4, and 3 parts sulphur dioxide per million parts of air.

The average temperature of the air blown into the cabinets was 26° C., and the average temperature at the end of the 10-minute period at the outlet end was 33° C., a rise of 7° C. being brought about during the passage through the cabinet.

The relative humidity at the inlet was 51 per cent and at the outlet 60 per cent.

The maximum temperature at the inlet was 38° C., and at the outlet end 51° C.

The relative humidity at this time was 20 per cent at both ends.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

The visible injury caused by daily fumigations of 10 minutes each was very great and corresponded with that produced by similar treatment at the Vallejo field.

Due to the smaller volume blown through the cabinet and the larger mass of vegetation present, the absorption of the sulphur dioxide was greater here than in most of the Vallejo plats. Thus the difference in the injury produced in the front and back of the plats was greater at Davis than at Vallejo. The absorption of sulphur dioxide was about 40 per cent during the travel through the cabinet. Thus we found the same injury at the far end of No. 1, which received 5 parts SO_2 per million parts of air, that was found at the front part of No. 3, which received 3 parts SO_2 per million parts of air. With these facts in mind it is interesting to compare the yield in the several

parts that were noted as having the same general appearance throughout the season.

Summary of experiments in series 2, Davis.

[53 10-minute fumigations made.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Check			477	2.64	1.10	4.19	26	100	100
3 (front)	3.0	0.0069	490	2.25	.89	3.69	24	95	81
3 (middle)	a 2.5		447	2.43	1.12	4.06	28	92	102
3 (back)	a 2.0		482	2.36	1.10	4.17	26	90	100
2 (front)	4.0	.0104	400	2.14	.85	3.45	25	81	77
2 (middle)	a 3.3		374	2.22	.84	3.80	22	84	76
2 (back)	a 2.6		390	2.23	1.07	3.84	28	84	97
1 (front)	5.0	.0130	423	1.79	.70	3.19	22	68	64
1 (middle)	a 4.0		433	2.28	.82	3.35	25	86	75
1 (back)	a 3.0		523	2.28	.89	3.77	24	86	81

a Approximate.

Average relative yields of entire plats.

Plat No.	Yield of straw and heads.	Yield of grain.
	Per cent.	*Per cent.*
Check	100	100
1	80	73
2	83	83
3	89	94

Comparison of yield from different parts of plats.

Plat No.	Part of plat.	Proportion of yield of check plat.	
		Heads and straw.	Grain.
		Per cent.	*Per cent.*
1	Middle	86	75
2	Front	81	77
1	Back	86	81
2	Middle	84	76
3	Front	85	81
2	Back	84	97
3	Middle	92	102

The back half of No. 3 showed only slight injury throughout the season and on the end gave a yield in "grain" about equal to the check.

Notes on plats 1, 2, and 3.

Grain 20 to 22 cm. high.

April 16, after five fumigations.—The first five fumigations have been made under relatively high humidity, that is, about 75 per cent. All plats show some injury.

Plat 1.—Shows a great deal of the "mottled" type injury. About 30 per cent of the foliage affected.

Plat 2.—Less affected, but showing injury of the "mottled" type.

Plat 3.—Still less affected, but also showing injury of the mottled type.

A question has arisen as to whether this injury is all sulphur dioxide bleach. Some of the mottling does not seem characteristic of sulphur dioxide.

April 18, after seven fumigations.—Appearance about the same as on April 16.

April 23, after 13 fumigations.

Plat 1.—Plants now about 30 cm. high and about the same height as No. 2 and No. 3 and the check. Injury now general over the whole plat, mostly the "mottled" type, but also some tips are bleached with the "concentrated" type. Undoubtedly some of the injury is due to bacterial disease. The youngest leaves the least affected and these show only the "mottled" type. Older leaves are more or less yellowish and dead at the tips.

Plat 2.—Injury generally all the "mottled" type. Larger proportion of dead leaves and yellowish leaves than in check plat. Part of injury probably due to some disease.

Plat 3.—Abnormal number of dried up and yellowish basal leaves. The injury on the green leaves all the fine "mottled" type. About one-half as bad as plat 2.

April 29, after 19 fumigations.

Plat 1.—Very few leaves that are not affected—either "killed back" or "mottled." Maximum height of plants, 42 cm.; minimum height of plants, 33 cm. Some difference in the injury showing at the front of the plat and at the back.

Plat 2.—Practically all leaves affected mostly with the "mottled" type of injury. Many dried-up basal leaves. Maximum height of grain 40 cm.; minimum 37 cm.

Plat 3.—Front of plat worse than back. Fine "mottled" type of injury. Grain is later than in No. 2. Maximum height is 45 cm.; minimum, 40 cm.

May 2, after 22 fumigations.—Grain now heading out very rapidly. In none of these plats do the heads look to be affected. The oldest leaves are nearly all dried up, though the youngest leaves are but slightly affected, the "mottled" type injury showing. A marked difference is now noted in the injury between the front and back of the plats. The back part of No. 1 looks about the same as the front part of No. 3. This difference bears out the analysis that the concentration at the back of No. 1 is only 3 parts SO_2 per million parts when the air blown in at the front carries 5 parts SO_2 per million parts of air.

May 7, after 26 fumigations.

Plat 1.—Now there is a very marked difference in appearance between the back and the front of the plat. The back third looks about the same as the middle of No. 2 or the front of No. 3. The grain is much shorter and has much smaller heads in front than in back. In front there is hardly a leaf that is not bleached. Even the sheath is "mottled." In the back part the new leaves are not affected, or only slightly so. Also there are not many old leaves in that part of the plat.

Plat 2.—In front this plat is about as the middle of No. 1, and the back is about as the middle of No. 3.

Plat 3.—The back of this plat is only slightly affected and the leaves here have only the "mottled" type injury. Heads over the plat are about normal size and well developed.

May 13, after 32 fumigations.

Plat 1.—Average plants about 40 cm. high in front and about 60 cm. high in back. Practically all foliage, even beards of heads, in front is bleached. Heads are not affected but are small and poorly developed in front. In back the heads are much larger and fuller and only 50 per cent of the foliage is bleached.

Plat 2.—Average plants about 50 cm. high in front and 65 cm. high at back. All leaves more or less "mottled" and beards also bleached. About 75 per cent of the foliage bleached or dead in front and about 35 per cent in back.

Plat 3.—Plants about 60 cm. high in front and 70 cm. high in back. Back of plat as high as check and not much leaf surface injured. Front is somewhat shorter than normal. The heads, however, appear normal. Some have mottling, due to bacterial disease.

May 28, after 42 fumigations.

Plat 1.—General appearance about the same as on preceding dates. No green foliage in front. Heads still green, but are very small and thin. Vegetation is greener and the heads are larger from front to back.

Plat 2.—Relative appearance of the grain in different parts of the plat the same as noted before. Heads appear about normal in size and development.

Plat 3:—Relative size of grain in the different parts of the plat is about the same as noted. Grain heads appear normal. No injury apparent in last third of plat.

June 17.—All the plats ripe and cut on this date. Each plat was divided into thirds and an area 1.12 square meters was cut out of each third as samples. Two check plats were cut. These plats had been allowed to grow normally and had received no fumigations of any character.

Results of experiments in series 2, Davis.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Average of checks	.....	1,410	534	520	97	572
1 (front)	1.12	848	475	466	98	326
1 (middle)	1.12	1,107	485	475	98	389
1 (back)	1.12	1,333	586	569	97	505
2 (front)	1.12	961	449	437	97	372
2 (middle)	1.12	930	418	404	97	339
2 (back)	1.12	993	437	437	100	408
3 (front)	1.12	1,247	554	541	98	480
3 (middle)	1.12	1,220	502	491	98	551
3 (back)	1.12	1,274	540	518	96	569

EXPERIMENTS IN SERIES 3.

PLATS 6, 7, 8, AND 9.

On 54 days between April 11 and June 13 these plats received a total of 199 fumigations, each of 5 minutes' duration. These fumigations were usually given four per day, with about an hour's interval between them.

Plats 6, 7, 8, and 9 received, respectively, fumigations of 1, 2, 3, and 4 parts SO_2 per million parts of air.

The average temperature of the air blown into the hood was 26° C., and the air at the outlet was 31° C. at the end of the 5-minute period. The average humidity of the air blown into the cabinet was 50 per cent, and at the outlet, at the end of 5 minutes, the average humidity was 57 per cent. The maximum temperature of ingoing air was 38° C., and of the air at the outlet 45° C.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

Plat 6, which received 1 part SO_2 per million parts air, was only slightly affected at any time. The injury on plats 7, 8, and 9 was similar to that produced on plats 32, 33, and 34, respectively, at

Vallejo. Plat 9, which received fumigations of 4 parts SO_2 per million, suffered very severely. In the latter part of the growth practically all foliage in the front part of this plat was bleached.

In these plats, as in plats 1, 2, and 3, the injury was considerably greater in the front than in the back portion of the plats. The grain yield for No. 6 was slightly greater than for the check plat. The other plats gave decreased yields in grain amounting to 10 per cent in the case of plat 7, 20 per cent in the case of plat 8, and 27 per cent in the case of plat 9.

Summary of experiments in series 3, Davis.

[199 5-minute fumigations.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Check			400	2.97	1.12	4.37	26	100	100
6 (front)	1.0	0.0026	492	2.78	1.21	4.20	29	94	108
6 (middle)			412	2.82	1.20	4.29	28	95	107
6 (back)			433	2.52	1.10	4.45	25	85	98
7 (front)	2.0	.0052	423	2.21	.98	4.16	24	74	88
7 (middle)			503	2.11	.95	3.98	24	71	85
7 (back)	[a] 1.2		450	2.47	1.09	4.06	27	83	97
8 (front)	3.0	.0069	482	1.73	.72	3.71	19	58	64
8 (middle)			403	2.20	.96	3.97	24	74	86
8 (back)	[a] 2.0		381	2.15	1.00	4.02	25	72	89
9 (front)	4.0	.0104	271	1.68	.77	3.26	24	57	69
9 (middle)			310	1.79	.84	3.46	24	60	75
9 (back)	[a] 2.5		362	1.89	.85	3.98	21	64	76

[a] Approximate.

Average relative yields of entire plats.

Plat No.	Yield of straw and heads.	Yield of grain.
	Per cent.	*Per cent.*
Check	100	100
6	91	104
7	76	90
8	68	80
9	60	73

The total weight of "heads and straw" was in all cases less than the check, in the case of plat 9 the yield being only 60 per cent that of the check.

Notes.

April 13.—Nine fumigations under high humidity conditions; average 65 to 70 per cent.

Plat 6.—No injury visible.

Plat 7.—Very faint spotting of a few leaves in front.

Plat 8.—"Mottling" of leaves over plat, especially in front.

Plat 9.—General "mottling" of leaves all over plat.

April 16.—Twenty-one fumigations.

Plat 6.—No injury visible.

Plat 7.—Slight "mottling" over the front of the plat.

Plat 8.—Increase of "mottled" area over that of April 13.

Plat 9.—General "mottled" injury, with some indications of the "concentrated" type.

April 23.—Fifty-one fumigations. Plants at this time about 36 cm. high.

Plat 6.—At this date a few slight traces of "mottling" and tip injury noted in front.

Plat 7.—Slight injury of the "mottled" type over the whole plat.

Plat 8.—Three or four times as much injury to No. 8 as to No. 7. "Mottled" type injury.

Plat 9.—Injury appears about three times as great as in plat 8. Some "mottled" type, but generally the white "concentrated" type.

April 29.—Seventy-six fumigations.

General appearance of the plats about the same as on the 23d.

Plat 6.—Shows slight injury only on a few leaves in front.

Plat 9.—Looks about the same as does plat 1.

May 2.—Eighty-three fumigations.

Grain now just starting to head out. Plants in plat 9 are shorter than the plants in plats 6, 7, 8, or the check. The damage is evidently worse than in plat 1.

May 7.—One hundred and one fumigations.

Plat 6.—Shows very few leaves slightly "mottled." Grain is of good height, about the same as check, except in the back, where it is about 10 cm. taller and is well headed out.

Plat 7.—Many slightly "mottled" leaves in front; only a few in the back. Plants are tall as normal and well headed.

Plat 8.—Badly injured in front; about 60 per cent of foliage is bleached at that part. Less injured at the back. Front averages about 5 cm. shorter than back. Heads are not bleached and appear about normal.

Plat 9.—Marked difference between front and back portions of plat. Very severe injury in front, practically all foliage is bleached. Heads are green, but are smaller than normal. Injury decreases from front to back. Back now looks as does the front of plat 8.

May 13.—One hundred and twenty-five fumigations.

Plat 6.—As on the 7th. Plants about normal height—that is, about 55 to 70 cm. tall. Shows only very slight injury.

Plat 7.—Plants normal height. Slight injury in front. Heads appear all right.

Plat 8.—"Mottled" type injury general all over the plat, the amount decreasing from front to back. About half of foliage affected. Plants in front are smaller than normal.

Plat 9.—Very severe injury all over the plat. Only youngest leaves retain any green color. About four-fifths of all foliage is bleached white and "mottled." Plants are much shorter than the check. Heads are decidedly shorter and less developed.

May 28.—One hundred and fifty-nine fumigations.

Plat 6.—Plants are normal in height in front and heads are well developed. Average height, 65 cm. Except for abnormally large number of dried basal leaves, no sign of injury evident. In back, the plants are shorter than in front, due to natural growth.

Plat 7.—Average height, 60 cm. A few traces of sulphur dioxide mottling now evident. Heads appear slightly smaller than in check or in No. 6.

Plat 8.—Average height of plants 60 cm. Not much shorter than in plat 7. Heads appear slightly smaller than in plat 7.

Plat 9.—Reduced growth and slight delay in ripening now very evident. Average height about 55 cm., and only about 45 to 50 cm. in front. On the few remaining

green leaves much "mottling" is evident. Plat still shows decided decrease in visible injury from front to back. Heads are much smaller than normal.

June 17.—All plats were ripe and ready to cut on this date. Plat divided into thirds and samples of 1.12 square meters area were taken from each, as in the case of plats 1, 2, and 3.

Results of experiments in series 3, Davis.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Average of checks	.....	1,332	448	431	96	485
6 (front)	1.12	1,529	551	533	97	646
6 (middle)	1.12	1,302	461	455	99	547
6 (back) [a]	1.12	1,218	484	473	98	519
7 (front)	1.12	1,046	473	462	98	451
7 (middle)	1.12	1,187	563	549	97	524
7 (back)	1.12	1,246	504	490	97	534
8 (front)	1.12	933	540	526	97	379
8 (middle)	1.12	992	451	436	97	417
8 (back)	1.12	920	427	420	98	422
9 (front)	1.12	508	303	293	97	225
9 (middle)	1.12	622	347	337	97	283
9 (back)	1.12	766	405	400	99	339

[a] Grain in this part of plat shorter, due to natural causes.

EXPERIMENTS IN SERIES 4.

The plats in this series were fumigated to determine the possibility of "invisible" injury. They were fumigated from time to time to the point of showing a slight visible bleach.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

Plats 4 and 5 comprise this series. These plats were given 10-minute fumigations of 1 and 2 parts SO_2 per million parts of air, by volume, respectively, until bleaching began to be quite severe on plat 5, then fumigation stopped for several days and the plants were allowed to recover before fumigations were resumed. Between April 11 and 23, inclusive, these plats received 46 10-minute fumigations. No fumigations were made on these plats then until May 4. Then 20 fumigations were given between May 4 and 18, inclusive. Fumigations resumed on May 28 and continued to June 12, during which time 12 fumigations were made. Thus, total fumigations equal 78.

The average temperature of the air blown into the cabinet was 27° C. The average temperature of the air at the back of the cabinet at the end of the 10-minute periods was 30° C. The average relative humidity of ingoing air was 55 per cent and of the outgoing air at end of 10-minute periods was 65 per cent.

The yield from these plats averaged 5 per cent greater than the yield from the checks, both in regard to the total weight of "straw and heads" and in regard to the "grain" yield. It was thought that this slight increase might be due to a "hothouse" effect in the cabinet during the fumigations; however, as will be shown in a table

given below it was found by experiments that the "hothouse" effect in 10-minute fumigations did not influence the yield, and thereby did not offset any "invisible" injury that might have been incurred. Thus, it must be concluded from these experiments on "invisible injury" that such injury does not exist. If grain is kept just partly bleached during the growing season and still yields a normal crop, the "invisible" injury is not appreciable or is nonexistent.

Summary of results of experiments in series 4, Davis.

[78 10-minute fumigations for "invisible-injury" data.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Check	.....	.....	518	2.64	1.10	4.19	26	100	100
4 (front)	1.0	0.0026	563	2.34	1.11	4.33	25	89	101
4 (back)	1.0	.....	474	2.72	1.22	4.00	30	103	111
5 (front)	2.0	.0052	505	3.06	1.15	4.22	27	116	105
5 (back)	2.0	.....	539	2.77	1.15	4.24	27	105	105

Notes.

April 16.—Seventeen fumigations.

Plat 4.—No visible damage.

Plat 5.—Slight "mottling" appeared on the plat near the front.

April 23.—Forty-six fumigations.

Plat 4.—Very slight "mottling" appears on some leaves near the inlet. None at the back end.

Plat 5.—"Mottled" type injury general over the whole plat. Injury about 5 to 8 per cent. Older leaves most affected.

April 28.—No fumigations since April 23.

Plat 4.—No signs of injury are visible.

Plat 5.—Old injury still visible, but appearance of plants much better than on April 23.

May 2.—

Plat 4.—Free from injury.

Plat 5.—Almost free from injury except many dead leaves around base; more than normally.

May 4.—Fumigations resumed. Grain now heading out.

May 13.—Fifty-nine fumigations. Well headed out and heads of good size; "in milk."

Plat 4.—No visible injury.

Plat 5.—Slight damage on a few leaves in front, and none in the back.

May 18.—Sixty-six fumigations.

Plat 4.—Suspicion of injury showing on this plat.

Plat 5.—Considerable bleaching all over this plat, about 15 per cent, of the "mottled" type.

Fumigations ceased temporarily.

May 28.—No fumigations since the 18th.

Plat 4.—No injury showing. Youngest leaves are green, oldest are pretty well dried up. Appearance normal.

Plat 5.—Not so near ripe as No. 4. No injury to present green leaves. Older leaves are dried up. Grain now in "dough" and beginning to ripen.

Fumigations resumed.

June 12.—Seventy-eight fumigations.

Fumigations continued up to time all grain ripe. As all foliage is dried up at this time, it is impossible to determine whether any injury was done to that portion of plant. Grain itself looks normal on both; large heads and well filled out.

Cut on June 17.

Area, 1.12 square meters.

Results of series 4, Davis, "invisible damage" determinations.

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Check	1.12	1,529	580	560	96	615
4 (front)	1.12	1,478	632	620	98	692
4 (back)	1.12	1,446	532	512	96	624
5 (front)	1.12	1,728	565	560	99	647
5 (back)	1.12	1,673	604	588	97	679

EXPERIMENTS IN SERIES 5.

This series consists of plats 16, 17, 18, and 19. These plats were given fumigations at times when the humidity of the air was less than 50 per cent. The length of each fumigation was five minutes. Plats 16 to 19 received, respectively, 1 to 4 parts SO_2 per million parts of air by volume in each fumigation. The fumigations were given on the following dates:

Date.	Number of fumigations.
Apr. 17	2
19	1
20	2
28	2
29	1
30	4
May 6	4
7	4
9	3
11	3
12	3
13	2
27	2
28	2
30	2
June 2	4
3	2
8	4
9	4
10	2
12	2
13	4
	59

The average temperature of the air blown into the cabinet was 28° C., and the relative humidity was 40 per cent.

The average temperature of the air at the far end of the cabinet at the end of the 5-minute periods was 32° C., and the humidity 50 per cent.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

A decrease was noted in the extent of the injury produced by fumigations under low humidity conditions, compared with the injury produced by an equal number of similar fumigations under higher humidity conditions. However, as these plats were not fumigated as frequently on as many successive days, a more definite comparison with the results obtained in series 3 can not be made.

A rough estimate of the relative injury produced by series 3 and 5 would be that in series 5 under lower humidities (average 55 per cent) the average injury per fumigation was three-fourths of that produced in series 3 under the high humidity (70 per cent) which prevailed during the first week that these plats were fumigated.

Summary of results of experiments in series 5, Davis.

[59 5-minute fumigations under comparatively low humidity conditions.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
16	1.0	0.0026	320	3.39	1.74	4.84	36	100	100
17	2.0	.0052	237	3.37	1.44	4.59	31	100	83
18	3.0	.0078	381	3.00	1.04	4.35	24	89	60
19	4.0	.0104	294	2.27	1.43	4.59	31	67	82

Notes.

April 23.—Five fumigations.

Plat 16.—No visible injury.

Plat 17.—No visible injury. Some yellowing of a few leaves.

Plat 18.—Fine "mottling" on a few scattered leaves over the plat.

Plat 19.—About 10 per cent of foliage affected by the fine yellow "mottled" type bleaching.

April 29.—Eight fumigations total—5 before April 20 and 3 subsequent.

Plat 16.—No signs of injury. Plants are higher in front than in back.

Plat 17.—No signs of injury. Plants are lower in front than in back.

Plat 18.—Few traces of old injury, but none of new.

Plat 19.—Traces of old injury apparent, also slight "mottling" caused by the three recent fumigations.

May 2.—Twelve fumigations.

Plats 16 and 17.—Show no signs of damage.

Plat 18.—Shows some slight signs of recent "mottling."

Plat 19.—"Mottling" caused by recent fumigations very evident.

May 7.—Twenty fumigations.

Plat 16.—No injury whatever.

Plat 17.—Shows very slight "mottling."

Plat 18.—Quite "mottled" in front, looks about as plat 7 front. Only slight injury to back of plat.

Plat 19.—Is quite injured in front, but only slightly, like No. 17 in back.

May 13.—Thirty-one fumigations.

Plat 16.—No injury visible except abnormal number of dead basal leaves present.

Plat 17.—"Mottled" leaves showing at front. None at back. Otherwise plat looks normal.

Plat 18.—About one-fourth of all leaves in front are mottled. Only a few in back. Plants look normal size.

Plat 19.—About half of all leaves in front of plat affected, "mottled" type injury. Only 10 per cent or so affected in back.

No fumigations on May 13 to 27 because humidity usually was too high.

May 28.—Thirty-three fumigations.

Plants in these plats are very uneven and in some places are especially tall and rank. Will be difficult to get conservative quantitative data concerning the weight of straw.

Plat 16.—No injury visible.

Plat 17.—No traces of previous injury apparent. Plants appear normal in size. Heads well filled out.

Plat 18—A few traces of previous injury showing. Otherwise the plants look perfectly normal.

Plat 19.—Only few traces of previous "mottled" injury. Many dead leaves. Plants appear about normal though heads are not quite so ripe as in plats 16 and 17.

Fumigations were kept up during the ripening period.

June 13.—Fifty-nine fumigations.

Grain now ripe. All foliage is dry. With exception of heads in the front of plat 19 the heads are apparently normal.

June 17.—The advisability of trying to get any quantitative data from this series of plats was doubtful. No satisfactory check plat could be found, for the plats were very variable in character.

Plat 16.—Was higher in front than in back.

Plat 17.—Was higher in back than in front.

Plat 18.—Was lower in the middle than at the ends.

Plat 19.—Was comparatively lower throughout compared with plats 16, 17, and 18,

All the plats were cut.

Area, 2.8 square meters.

Results of experiments in series 5, Davis.

[59 5-minute fumigations under comparatively low humidity conditions.]

Plat No.[a]	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Sq. meters.	*Grams.*			*Per cent.*	*Grams.*
16	2.8	3,034	895	882	98	1,537
17	2.8	2,240	664	650	98	936
18	2.8	3,203	1,067	1,035	97	1,078
19	2.8	1,868	822	810	99	1,160

[a] No satisfactory check plat could be found for this series. As shown by the number of heads and weight of straw per square meter, these plats were very uneven and dissimilar. Thus, a comparison of the yields of these plats is of very little value.

EXPERIMENTS IN SERIES 6.

The experiments in this series consisted of plats Nos. 20, 21, and 22. These plats were fumigated for periods of 5 minutes, 42 times between April 29 and May 13, average three times per day, when the grain was heading and "in the milk" stage. The plats were shaded during the fumigations to determine the extent of injury in comparison with the injury produced in sunlight. Plats 20 to 22 received, respectively, concentrations of 2, 3, and 4 parts of SO_2 per million parts of air by volume.

The average temperature at the inlet was 26° C., and at the back end of the cabinet at the end of the 5-minute periods was 28° C. The average humidity at the inlet was 50 per cent and at the outlet 55 per cent.

SUMMARY OF RESULTS OF EXPERIMENTS IN THE SERIES.

The fumigations in the shade with 2, 3, and 4 parts SO_2 per million on plats 20, 21, and 22, respectively, did not produce as much visible damage to the foliage as did an equal number of similar fumigations in the sun on plats 7, 8, and 9. The difference, however, was not so great as that noted between the results of series 3 and series 5, where injury under high and low humidity conditions were compared.

As the fumigations of series 6 were made when the grain was heading out and was "in the milk" it was decided to obtain quantitative data concerning the effect on the yield of these fumigations. Two check plats were cut and their yield averaged for comparison.

In this series there was a gradual decrease in the total weight of the straw and heads per head from plats 20 to 22 amounting to 20 per cent in the case of No. 22. The yield of grain from plat 20 was the same as the check. The yield of grain per head from plat 21 was only 70 per cent and from plat 22, 86 per cent. This anomaly might be explained to a certain extent by the natural unevenness of the grain in the several plats.

Summary of results of experiments in series 6, Davis.

[42 5-minute fumigations in the shade.]

Plat No.	Concentration of SO_2.		Average number of heads per square meter.	Weight of—			Number of kernels per head.	Relative yield based on—	
	Parts per million.	Grams per cubic meter.		Heads and straw per unit head.	Grain per good head.	100 kernels.		Heads and straw.	Grain.
				Grams.	*Grams.*	*Grams.*		*Per cent.*	*Per cent.*
Average check	.....	.....	408	2.95	1.23	4.58	27	100	100
20	2	0.0052	365	2.78	1.23	4.93	25	94	100
21	3	.0078	364	2.58	.86	4.19	20	87	70
22	4	.0104	266	2.32	1.06	4.29	25	79	86

Notes.

May 2.—Twelve fumigations.

Plat 20.—No injury visible.

Plat 21.—Slight "mottling" showing.

Plat 22.—Considerable "mottling" beginning to show. On the older leaves the tips are bleached back.

May 7.—Twenty-three fumigations.

Plat 20.—Very faint "mottling" appearing.

Plat 21.—"Mottled" over whole plat.

Plat 22.—Very decided "mottled" appearance all over the plat. About 30 per cent of foliage affected.

May 13.—Forty-two fumigations. Grain well headed out.

Plat 20.—Shows some minute traces of the yellowish "mottle" type bleach.

Plat 21.—About 15 to 20 per cent of foliage in front "mottled." Less in back.

Plat 22.—Injury general all over this plat. About 70 per cent in front and 41 per cent in back. "Mottled" type injury predominates. Some "concentrated kill-back" type. The plants in the plat are smaller and thinner than the normal, due to a great extent to natural causes.

May 28.—Fifteen days after last fumigations.

Plat 20.—No signs of injury are present except larger proportions of dead basal leaves than normal. Otherwise normal.

Plat 21.—Very few signs of sulphur-dioxide bleach. Many dried dead leaves.

Plat 22.—Traces of old injury still visible. This grain is not so ripe as plat 20, 21, or the check plat. Heads are smaller and not so well filled out. Grain smaller, partly due to natural causes.

June 17.—Grain ripe and cut on this date.

Whole plats sampled 2.8 square meters; strip taken down through the center.

Results of experiments in series 6, Davis.

[Forty-two 5-minute fumigations in shade.]

Plat No.	Area sampled.	Total weight of straw and heads.	Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.
	Square meters.	*Grams.*			*Per cent.*	*Grams.*
Average check					97	
20	2.8	2,833	1,021	1,007	99	1,240
21	2.8	2,636	1,020	990	98	849
22	2.8	1,729	745	724	97	767

EXPERIMENTS IN SERIES 7.

In series 7 the effect of sunlight and shade compared with the effect of high and low humidity on the susceptibility of grain to sulphur dioxide was studied. The results are given below.

PLATS 12 AND 13.

Plats 12 and 13 were run for comparison purposes with concentrations of two parts of SO_2 per million parts of air, by volume. Plat 12 was fumigated in the early morning hours when the dew was going off and before the sun was very high.

Plats 13 was fumigated in the late afternoon, when the vegetation was perfectly dry and the sun was relatively low in the west.

Plat 12.—Between April 13 and 25 had eleven 15-minute fumigations.

Average temperature of air in cabinet—inlet, 21° C.; outlet, 21° C.

Average humidity of air in cabinet—inlet, 65 per cent; outlet, 78 per cent.

Plat 13.—Between April 12 and 24 had eleven 15-minute fumigations.

Average temperature of air in cabinet—inlet, 23° C.; outlet, 26° C.

Average humidity of air in cabinet—inlet, 58 per cent; outlet, 64 per cent.

The injury to plat 12 was somewhat greater than to No. 13. After the fourth fumigation to No. 12 "mottled" type bleaching appeared, especially in the smaller plants and on the oldest leaves.

Not until after the sixth fumigation on plat 13 did the "mottling" appear.

On April 23, after No. 12 had had 10 fumigations and No. 13 had had 11, No. 12 was worse injured than No. 13 by about 25 per cent. The injury to both of these plats was decidedly greater per fumigation than to plat 17, fumigated under lower humidity conditions.

The recovery of these plats was rapid. By May 13 neither plat had any visible remains of the old injury.

PLATS 14 AND 15.

Each of these plats was fumigated for one hour on April 18 with 5 parts SO_2 per million parts of air by volume, or 0.013 gram of SO_2 per cubic meter.

Plat 14.—This plat was fumigated in the sunlight.

Average temperature of air in cabinet—inlet, 26° C.; outlet, 30° C.

Average humidity of air in cabinet—inlet, 56 per cent; outlet, 52 per cent.

Plat 15.—This plat was fumigated in the shade.

Average temperature of air in cabinet—inlet, 26° C.; outlet, 28° C.

Average humidity of air in cabinet—inlet, 56 per cent; outlet, 60 per cent.

Notes.

May 23.—Very severe injury on both plats. All injury was principally of the "concentrated" kill-back type. Injury was only slightly greater on plat 15 than on plat 14—less than 10 per cent difference.

These tests show that the humidity conditions are of greater influence than sunlight or shade in influencing the susceptibility of the plants to sulphur dioxide.

EXPERIMENTS IN SERIES 8.

Even in the 5-minute fumigations at Davis there was usually an increase in temperature and humidity at the far end of the cabinet

before the end of the fumigation period. At the inlet end, however, where the greatest injury on any plat was produced, the temperature and humidity conditions were the same or nearly the same as for the outside air. Although it is improbable that at the inlet end there could have been any abnormal conditions present to vitiate our results, it was decided to try to duplicate some of the fumigations in the open air outside any cabinet to determine whether materially different results would be obainted.

The first attempts along this line were to discharge the mixture of air and sulphur dioxide directly into the atmosphere over a plant or row of plants. However, only the first or first two plants directly in the line of the discharge pipe received the calculated concentration. Diffusion or dispersion takes place so rapidly that the concentration of the sulphur dioxide at a point only a short distance away from the discharge pipe was much lower than the calculated. The concentration at any point was variable, depending on the wind conditions. In the several experiments carried out with this method of fumigations the plants directly in front of the delivery pipe showed about the same extent of injury as was brought about by fumigation in the cabinet under the same humidity conditions.

In order to increase the number of plants that would be so fumigated the fumigation mixture was discharged into a galvanized iron pipe shaped as a Y; from the two upper ends of this Y extended galvanized iron pipes 80 cm. in diameter and 610 cm. long. Along this pipe were cut holes 2.54 cm. in diameter and 7.6 cm. centers, through which the air mixture was discharged. The two parallel perforated pipes extending from the Y were about 15 cm. apart, which allowed their being set down on either side of a row of barley plants. By this method of conducting the air-gas mixture to the plants it was thought to be possible to surround the plants in the row with the desired mixture. This was found to be an improvement over the method of blowing directly from the fan, but still did not give the desired results.

On several tests the pipes were laid on the ground, the holes uppermost, and the air was discharged directly upward. Analysis of the air in the center of the space between the pipes—that is, between the leaves of the plants—averaged only 50 per cent of the calculated concentration. The leaves that extended out over the holes and so received the calculated concentration were affected in about the same manner and to the same extent as they were when fumigated in the cabinet.

In another series of tests the pipes were supported about 40 cm. from the ground and the pipes turned so that the air streams were discharged converging toward a point near the center of the plants. In this series the analysis of the air surrounding the plants showed

that the concentration approached more nearly the calculated strength. In this series the injury sustained by the plants in the direct line of the discharge was found to be approximately the same as that sustained by plants when treated with the same concentration in our cabinet. Tests were made with concentrations of 3, 5, and 10 parts per million.

Another series of tests was made in which a cabinet was placed over a plat and the air-gas mixture was distributed by the pipes described above. No materially different results were obtained than from those obtained by the usual fumigations under the cabinet, except that the injury to the vegetation was more even over the plat.

From these tests the conclusions were arrived at that except for the rise in temperature and humidity at the far end of the cabinet, no abnormal conditions were present in the cabinet fumigations which affected the susceptibility of the plants to such an extent as to influence the results.

SUMMARY OF ALL DATA CONCERNING "INVISIBLE" INJURY TO PLANTS.

The following table has been prepared to show the data obtained from all the plats that received fumigations to the extent of a very slight bleach or visible injury during the whole or a large portion of the growing season. In this table are included the data from the plats that were carried through expressly for the "invisible" injury data, namely, Vallejo plats 26 and 44 and Davis plats 4 and 5.

The data from the plats that were slightly bleached during the season are also given, namely, Vallejo plats 14, 31, and 37 and Davis plats 6 and 20.

From the data of these plats it is to be concluded that no "invisible" injury affected the growth or the fruiting of the grain, and that for a grain crop like barley, the possibility of such "invisible" injury taking place to an appreciable extent is very remote.

Summary of results of all experiments to determine "invisible" injury.

[Number of plats from which data were obtained, 9.]

Plat.	Average weight of—	
	Heads and straw per unit head.	Grain per good head.
	Grams.	*Grams.*
Fumigated a	2.80	1.33
Check	2.81	1.29

a Relative yield based on "heads and straw," 100 per cent; based on "grain," 103 per cent.

Summary of all data concerning experiments to determine "invisible" injury.

Plat No.	Concentration of SO_2.		Length of time of each fumigation.	Number of fumigations.	Period during which fumigations were made.	Weight of—				Comparative yield based on—	
	Parts per million.	Grams per cubic meter.				Heads and straw per unit head.		Grain per head.		Heads and straw.	Grain.
						Plat.	Check.	Plat.	Check.		
Vallejo.			*Minutes.*							*Per cent.*	*Per cent.*
14	1.0	0.0026	10	90	Mar. 26 to June 13	2.42	2.43	1.24	1.28	100	97
26	.5	.0013	60	29	Mar. 31 to Apr. 15	2.52	2.95	1.30	1.22	85	106
31	1.0	.0026	5	186	Apr. 1 to June 12	3.00	2.56	1.51	1.31	117	115
37	1.0	.0026	5	33	Apr. 6 to Apr. 16	2.91	3.07	1.64	1.68	95	98
44	.5	.0013	60	62	Apr. 15 to June 12	3.44	3.11	1.54	1.55	111	100
Davis.											
4	1.0	.0026	10	78	Apr. 11 to June 12	2.53	2.64	1.16	1.10	96	105
5	2.0	.0058	10	78	do	2.92	2.64	1.15	1.10	110	105
6	1.0	.0026	5	199	do	2.71	2.97	1.17	1.12	91	105
20	2.0	.0058	5	42	Apr. 29 to May 13	2.78	2.95	1.23	1.23	94	100

COMPARISON OF YIELDS OF CHECK PLATS.

The following figures show the comparative yields of three check plats taken side by side.

Plat 1 was allowed to grow normally.

Plats 2 and 3 were each fumigated 56 times for periods of five minutes with air containing no sulphur dioxide.

At no time was there any injury on the fumigated checks or any abnormal leaf markings present on the checks that were fumigated, which were not also present on the unfumigated checks. Thus, no visible injury or markings that resembled sulphur dioxide injury were present on the leaves of the fumigated plats.

A comparison of their quantitative yields is given below:

Comparison of yields of check plats.

[Plat 1 was not fumigated; plats 2 and 3 were each fumigated 56 times for periods of 5 minutes with air containing no SO_2.]

Plat No.	Weight of heads and straw.		Total number of heads.	Number of good heads.	Proportion of total.	Total weight of grain.	Weight of grain per good head.	Weight of grain per 100 grains.	Number of grains per head.	Relative yield based on—	
	Total weight.	Weight per head.								Heads and straw.	Grain.
	Grams.	*Grams.*			*Per ct.*	*Grams.*	*Grams.*	*Grams.*		*Per ct.*	*Per ct.*
1	1,406	2.96	475	460	97	582	1.26	4.54	28	100	100
2	1,529	3.03	524	508	97	615	1.21	4.53	27	102	100
3	1,047	2.85	368	360	98	439	1.22	4.67	26	96	103

EFFECT OF FUMIGATION UPON DISEASES OF PLANTS.

In the Vallejo field during May there developed, in a great many spots, a yellowing of the foliage of the grain. In fact, the yellowing was pretty general all over the field, and when referred to the plant pathologists was found to be due to a fungus disease. There is very little doubt that part of the yellow bleaching noted during April, in plats 31 to 35 and 17 and 18, which received 5 and 10 minute fumigations, was due to this disease. That being the case, the evidence would seem to point to the conclusion that the plants were rendered especially susceptible to the disease by the continued short-time fumigations. However, none of the plats that were severely bleached once or twice had an abnormal number of the yellowish leaves.

At Davis, plat 26 received a very severe fumigation and severe bleach appeared. At the end of the season the old bleached leaves in this plat appeared to be severely attacked by a fungus disease—"Helminthsporium"[a]—none more so than the check. On the other plats, however, no appreciable difference was noted in the extent of this disease between fumigated and check plats.

In general the fumigated plats had a smaller percentage of moldy heads.

Comparison of percentage of good heads to total heads.

Series No.	Proportion of good heads to total heads.		Series No.	Proportion of good heads to total heads.	
	Check plat.	Fumigated plat.		Check plat.	Fumigated plat.
Vallejo experiments.	*Per cent.*	*Per cent.*	*Davis experiments.*	*Per cent.*	*Per cent.*
1a and 1b	89	90	1	97	99
1c	81	93	2	97	98
2	83	92	3	96	97
3	88	89	4	96	97
4	86	85	5	98	98
5	89	88	6	97	98
6	84	87			
7	91	93			
9a	81	88			
Average	86	89	Average	97	98

[a] Sulphur trioxide used in this series.

It is noted that plats 1*c*, 2, and 9, which received comparatively strong fumigation while the heads were filling out, had the greatest difference in percentage of good heads between plats and check.

The relative yield of the grain from the fumigated and check plats was based on the average weight of grain per good head. However, as the percentage of good heads to the total was greater in the case of the check plats, by basing the yield of grain on the weight per unit total head the figures for the fumigated plats would be slightly increased. However, those from series 1*c* and series 2 are the only figures that would be seriously affected by the change.

[a] Dr. Blankinship's identification.

DETERMINATION OF SULPHUR IN THE PLANT FOLIAGE.

In connection with the investigation of injury to growing barley by sulphur dioxide, it was considered important to determine whether the plants subjected to the action of sulphur dioxide showed an increase in the amount of sulphur present in the foliage and grain kernels above that found in plants not subjected to the gas.

METHOD OF SAMPLING.

When the barley had been cut and weighed, samples of the dried leaves were taken for the determination of their sulphur content. About 30 grams of the leaves was taken from each sample. In the laboratory the foliage was cut into pieces less than 2.5 cm. long, and the size of each sample was reduced from 25 to 10 grams. These 10-gram samples were dried at 95° C. for 48 hours and then ground to a fine powder in a drug mill. This powder was placed in a small weighing bottle and dried at 95° C. for 24 hours.

METHOD OF ANALYSIS.

The method employed in these analyses was essentially the fusion method described in Bulletin 107, Bureau of Chemistry, United States Department of Agriculture.

The analyses were made by Mr. G. C. Bartells and Mr. C. E. Brandt in the laboratory of Gould, Free & Ash.

One gram of the dried powder was transferred to a nickel crucible of 250-c. c. capacity, 2 c. c. of water and 5 grams of sodium carbonate were added, and the mixture was stirred carefully. Five grams of sodium peroxide was added in small amounts and well stirred in with the rest of the mixture.

The crucible was then placed in a small specially designed electric furnace of the resistance type and the material fused down slowly. Small amounts of sodium peroxide were added and the crucible rotated until the fusion was perfect. The crucible was kept at the fusion temperature for about 10 minutes and then cooled. It was then covered with a watch glass, 100 c. c. of water was added by a pipette, and the crucible was placed on an electric hot plate to effect solution.

The resulting solution was washed into a No. 5 Jena beaker, hydrochloric acid in excess was added slowly by a fine capillary pipette, and the solution was evaporated to dryness on the hot plate. After dehydration the soluble salts were dissolved in 5 c. c. HCl and 150 c. c. H_2O, and the solution was heated and filtered.

The filtrate and washings were diluted to 350 c. c. and cooled. Then 10 c. c. of 5 per cent $BaCl_2$ was added very slowly through a small-bore tube and without stirring. The solution was then allowed

to stand 48 hours, when it was filtered through a weighed Gooch crucible, washed with water and then with alcohol-ether, dried for 2 hours at 120° C., and then weighed.

Samples of barley kernels were ground to a powder, sampled, dried, and analyzed, as were the foliage samples.

Results of analyses to determine sulphur in plant foliage, Vallejo samples.

Plat No.	SO_2 treatment.	Sulphur content.	
		In foliage.	In kernels.
		Per cent.	*Per cent.*
Check		0.34	.....
9	1 part SO_2 per million for 43 hours during early growth	.45	.....
Check		.49	0.15
22	2 1-hour fumigations of 10 parts SO_2 per million during early growth	.57	.26
Check		.36	.....
74	35 2-minute fumigations of 5 parts SO_2 per million	.40	.....
Check		.38	.....
46	3 1-hour fumigations of 5 parts SO_2 per million	.52	.....
20		.41	.....
21	90 60-minute fumigations with 1 part SO_2 per million	.56	.....
12	181 30-minute fumigations with 1 part SO_2 per million	.64	.....
Check		.46	.....
7	198 15-minute fumigations with 2 parts SO_2 per million	.62	.....

Results of other sulphur determinations, Vallejo samples.

SAMPLES FROM SERIES 2.

[Ninety 10-minute fumigations.]

Plat No.	SO_2 treatment—parts per million.	Proportion of sulphur.	
		In foliage.	In grain.
		Per cent.	*Per cent.*
Check	0	0.43	0.17
14	1.0	.43	.15
15	2.0	.47	.18
16	3.0	.55	.24
17	4.0	.75	.26
18	5.0	.82	.25

SAMPLES FROM SERIES 3.

[One hundred and eighty-six 5-minute fumigations.]

Check	0	0.47	No analysis.
31	1.0	.48	Do.
32	2.0	.50	Do.
33	3.0	.53	Do.
34	4.0	.59	Do.
35	5.0	.65	Do.

SAMPLES FROM SERIES 4.

[Thirty-three 5-minute fumigations.]

Check	0	0.43	No analysis.
37	1.0	.47	Do.
38	2.0	.49	Do.
40	3.0	.43	Do.
41	4.0	.49	Do.
42	5.0	.45	Do.

The following figures, showing the sulphur content of foliage subjected to severe fumigation with sulphur trioxide fume, are of special interest:

Results of experiments in which foliage was subjected to severe fumigation with SO_3.

Plat No.	Character of sulphur trioxide fumigation.	Proportion of sulphur.	
		In foliage.	In kernels.
		Per cent.	*Per cent.*
Check		0.52	0.14
80	0.015 gram per cubic meter—2-hour fumigation	.52	.13
82	0.018 gram per cubic meter—1-hour fumigation	.54	.14
89	0.021 gram per cubic meter—2½-hour fumigation	.52	.14

Results of analyses to determine sulphur in plant foliage, Davis samples.

SERIES 1.

Plat No.	SO_3 treatment.	Sulphur content.	
		In foliage.	In kernels.
		Per cent.	*Per cent.*
Check		0.18	0.19
11	5 parts SO_3 per million for 1 hour during early growth	.24	.19
Check		.15	.14
26	10 parts SO_3 per million for 1½ hours, when grain headed out	.27	.18

SERIES 2.

[Fifty-three fumigations of 10 minutes each.]

Check		0.22	0.16
3	3 parts SO_3 per million	.41	.18
2	4 parts SO_3 per million	.43	.19
1	5 parts SO_3 per million	.47	.20

SERIES 3.

[One hundred and ninety-nine fumigations of 5 minutes each.]

Check		0.18	0.16
6	1 part SO_3 per million	.26	.19
7	2 parts SO_3 per million	.34	.20
8	3 parts SO_3 per million	.43	.18
9	4 parts SO_3 per million	.49	.17

SERIES 4.

["Invisible-injury" experiments—78 10-minute fumigations.]

Check		0.18	.....
4	1 part SO_3 per million	.26	.....
5	2 parts SO_3 per million	.34	.....

In order to determine whether this sulphur was present as sulphides, sulphites, sulph-aldehydes, or fixed sulphates, tests were made as follows:

Samples of the vegetation from plats that had received strong fumigations; that is, No. 17 and 18 and a check plat, were dried to constant weight at 90° C., and 5 to 10 grams was cut into fine pieces with shears and introduced into a 1,500-c. c. round-bottom glass flask. To the flask were added 500 c. c. of distilled water and 10 c. c. of phosphoric acid, and then about 5 grams of sodium carbonate to furnish an atmosphere of cabon dioxide to displace the air.

The flask was connected immediately with a 250-c. c. absorption flask containing about 50 c. c. N/10 iodine solution. An outlet trap from this absorption flask contained about 10 c. c. of iodine solution.

As soon as the connections were made a flame was put under the distillation flask and the contents were brought to a boil, and boiling was continued until about 200 c. c. had collected in the absorption flask. The glass connections were then washed out into a beaker with the contents of the absorption flask.

To insure complete oxidation of the distilled sulphur compounds, the solution was treated with bromine water, after which the bromine was boiled off and the solution was made slightly acid with 5 c. c. of HCl, and the $BaSO_4$ precipitated with $BaCl_2$ solution (about 10 c. c. of a 5 per cent $BaCl_2$ solution). The precipitate was allowed to settle about 24 hours and was then filtered through a Gooch crucible, if enough precipitate was present to filter off.

Results of tests to determine form in which sulphur was present in foliage that had been fumigated.

Number of plat from which sample was taken.	Total sulphur content of foliage.	Sulphur present as sulphoaldehyde.
Vallejo.	*Per cent.*	*Per cent.*
Check	0.43	<0.010
17	.75	.014
18	.82	.014

Blank tests on the reagents failed to give a precipitate of $BaSO_4$.

These tests show that no appreciable amount of sulphur was present in the foliage as sulphoaldehyde. All sulphur was present in fixed combinations.

SUMMARY OF RESULTS OF DETERMINATIONS.

SULPHUR CONTENT OF FOLIAGE.

The sulphur content of foliage that was fumigated with sulphur dioxide was in all cases greater than that of the foliage in the corresponding check plats. In Vallejo series 2 and 3 and Davis series 3 and 4 the sulphur content was greater in the foliage that had received the higher concentration.

It is to be noted that considerable difference existed in the sulphur content of the checks' foliage. In Vallejo check samples, the sulphur content of the foliage varied between 0.34 and 0.52 per cent. The Davis check foliage had more nearly the same sulphur content—between 0.15 and 0.22 per cent.

These data confirm the opinion that the determination of the sulphur content of vegetation is not sufficient alone to determine the extent of the damage that the vegetation may have endured by sulphur dioxide, for great differences are found in the sulphur content of normal uninjured vegetation. In this connection it is interesting to note the conclusions of Tatlock and Thomson.[a]

The claim has been made to the writer that whenever crops of hay have been subjected to sulphur dioxide fumigation and bleached, the sulphur content is increased to the extent that the crops are injurious to animals feeding thereon. If such a condition does exist, it certainly is not due to the increase of sulphur content, for there are differences in the sulphur content of normal unfumigated foliage as great as between bleached and normal foliage.

The foliage from the plats fumigated with heavy sulphur trioxide fume had no greater sulphur content than did the check. This indicates that no sulphur trioxide vapor was absorbed and that no fume was precipitated.

The sulphur was present as sulphates or in other stable compounds.

SULPHUR CONTENT OF GRAIN KERNELS.

The increase of the sulphur content in fumigated grain over that in check grain, although determinable, is very slight.

GERMINATION TEST OF SEEDS.

To determine the effect of sulphur dioxide fumigations upon the germinating power of the grain, samples from various plats of the Davis and Vallejo fields were sent to the seed laboratory of the United States Bureau of Plant Industry, conducted in collaboration with the Agricultural Experiment Station of the University of California.

These germination tests were six days in duration, and were made on the grain about 60 days after the grain had been threshed.

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[a] Tatlock, R. R., and Thomson, R. T., Damage caused to vegetation by sulphurous and sulphuric acids in the atmosphere: Analyst, vol. 39, May, 1914, pp. 203-210.

Results of germination tests of barley samples.

SAMPLES FROM VALLEJO EXPERIMENTS IN WHICH VARIOUS TREATMENTS WERE GIVEN.

Plat No.	Treatment of plats.	Germination.
		Per cent.
Check		100
22	2 1-hour fumigations of 10 parts SO_2	90.5
Check		94
98	Fumigated with 6 parts SO_2 per million for 20 minutes while grain was "in dough".	95.5
100	Fumigated with 6 parts SO_2 per million for 2½ hours while grain was "in dough".	91.5

SAMPLES FROM EXPERIMENTS IN VALLEJO SERIES 2—NINETY 10-MINUTE FUMIGATIONS.

	Parts SO_2 per million.	
Check		98
14	1	99
15	2	98
16	3	98
17	4	96
18	5	89

SAMPLES FROM VALLEJO PLATS TREATED WITH SULPHUR TRIOXIDE FUME FUMIGATIONS.

Check		82.5
89	Fumigated with 0.021 gram of SO_3 per cubic meter for 2½ hours	85.5
Check		94
96	Fumigated with 0.033 gram of SO_3 per cubic meter for 1½ hours	92.5

SAMPLES FROM DAVIS EXPERIMENTS IN WHICH VARIOUS TREATMENTS WERE GIVEN.

Check		93
11	Fumigated with 5 parts of SO_2 per million for 1 hour during early growth	90.5
Check		97
26	Fumigated with 10 parts of SO_2 per million for 1½ hours when grain was "in dough."	94.5

SAMPLES FROM EXPERIMENTS IN DAVIS SERIES 2.

[Fifty-three 10-minute fumigations.]

	Parts SO_2 per million.	
Check		97
1	5	88.5
2	4	91.5
3	3	97

SAMPLES FROM EXPERIMENTS IN DAVIS SERIES 3.

[One hundred and ninety-nine fumigations of 5 minutes each.]

	Parts SO_2 per million.	
Check		97
6	1	95
7	2	97
8	3	98
9	4	96

LABORATORY EXPERIMENTS TO DETERMINE THE RATE OF DISAPPEARANCE OF SULPHUR DIOXIDE FROM DILUTE MIXTURES.

In the fumigation experiments at Vallejo and Davis it was found that if a mixture of sulphur dioxide and air was contained in a closed cabinet over vegetation or soil there resulted a very rapid disappearance of the sulphur dioxide from the mixture. This rapid disappearance was found to take place both in the regular fumigation experiments in the celluloid cabinets and in the special experiments in the glass cases. With the apparatus at hand in the field it was not possible to determine accurately whether this disappearance was due entirely to absorption by the vegetation or was due partly to oxidation to sulphur trioxide. Thus it became necessary to carry out some similar experiments in the laboratory to check the field experiments and to determine the extent of the oxidation of sulphur dioxide to trioxide. These experiments were conducted in the laboratory of the Bureau of Mines at San Francisco by Mr. G. C. Bartells, jr., assisted during part of the time by Mr. G. N. Libby.

This experimental work was divided into two series. In one series data were obtained concerning the rate of disappearance of sulphur dioxide from a mixture in contact with vegetation or soil, confirming the data obtained in the field experiments. In the second series data were obtained concerning the rate of disappearance of sulphur dioxide from a mixture of that gas and air contained in a closed glass container under different conditions as to humidity and sunlight. Some data were obtained in this series to explain the disappearance of the sulphur dioxide—whether due to oxidation to the trioxide or due to "adsorption" on the walls of the glass container.

In the experiments to determine the rate of disappearance of the sulphur dioxide from a mixture in contact with vegetation a 36-liter carboy was used as a container. The bottom of this carboy had been removed to allow setting the carboy down over the plants growing in a box, the soil in the box forming the bottom of the carboy. When tests were made on potted plants or cut foliage the carboy was placed on a glass plate which was ground to make a tight joint with the walls of the carboy.

The method of carrying out the tests and the details of the data obtained are described in the report of Mr. G. C. Bartells, jr. (pp. 308–323).

The laboratory experiments confirmed the data obtained in the field by showing that the disappearance of sulphur dioxide from a mixture of that gas and air held in a closed container in contact with vegetation is very rapid. For example, several tests with an initial concentration of 28 parts SO_2 per million parts of air in the carboy over barley plants showed a disappearance of about 80 per cent of the

sulphur dioxide from the mixture in less than 3 minutes and 95 per cent in 10 minutes. In less than 40 minutes the disappearance was complete.

In contact with the soil alone the disappearance of sulphur dioxide was very rapid, though not so rapid as when growing vegetation was present. In less than 10 minutes over 90 per cent of the sulphur dioxide had disappeared. The disappearance did not go to completion in this case, however, a residue of about 2 per cent of the original concentration, or about 0.0010 gram SO_2 per cubic meter, remaining in the gas phase after several hours.

It was found also that green vegetation, although cut from the vines, shrubs, or trees, absorbed the sulphur dioxide very rapidly. From concentrations of approximately 37 parts SO_2 per million a variety of cut vines and other foliage effected a disappearance of about 40 per cent of sulphur dioxide in 10 minutes. In this case also the disappearance of the sulphur dioxide did not go to completion, a residual concentration of about 0.5 part SO_2 per million parts of air by volume remaining in the carboy for several hours.

In the experiments to determine the rate of disappearance of sulphur dioxide from dilute mixtures of that gas and air held in a glass container it was found that in diffused light and with dry atmosphere the disappearance of the sulphur dioxide was very slow. In 2 hours no determinable amount of sulphur dioxide had disappeared. In 30 hours less than 10 per cent had disappeared. In diffused light and with some moisture present (about 50 per cent of the amount required to saturate the atmosphere of the carboy) the disappearance was more rapid, approximately 20 per cent disappearing in 30 hours. Under the same diffused light, but in an atmosphere saturated with water vapor and with excess water present in the carboy, the disappearance was still more rapid, 50 per cent disappearing from the gas phase in 10 minutes and about 90 per cent disappearing in 20 hours. The amount that disappeared in these two latter cases was greater than could be held in direct solution in the water in equilibrium with the gas concentration. This fact indicates that oxidation was very rapid or that the sulphur dioxide was chemically combined with the alkaline salts from the glass or else that "adsorption" on the walls of the glass took place.

In the direct sunlight the disappearance of the sulphur dioxide was more rapid than in the diffused light. Unfortunately these experiments in the sunlight were not conducted under the same range of humidity conditions as were the experiments in the diffused light. In a comparatively dry atmosphere, during a period of about 45 hours, during 11 of which there was direct sunlight, the total disappearance was 38 per cent as against only 10 per cent in diffused light.

The data concerning the oxidation of sulphur dioxide to the trioxide in dilute mixtures contained in glass vessels indicate that the action is comparatively slow.

When sulphur dioxide was present to the extent of about 30 parts SO_2 per million parts of air by volume (0.091 gram per cubic meter) in a dry carboy for a period of about 60 hours, during 12 hours of which there was direct sunlight, approximately 10 per cent of the sulphur dioxide was oxidized to the trioxide.

In an atmosphere saturated with water vapor and with excess moisture present, in diffused light, the oxidation to the trioxide took place more rapidly, 20 per cent being converted to the trioxide in 20 hours.

The oxidation to the trioxide did not account entirely for the disappearance of the sulphur dioxide in the experiments of series 2. These investigations show that "adsorption" took place, a determinable amount of the sulphur dioxide being found on the walls of the carboy even under conditions of comparative dryness. With excess moisture present, this "adsorption" took place to a greater extent. From a concentration of about 0.091 gram per cubic meter, in 20 hours approximately 50 per cent of the sulphur dioxide originally present in the gas phase was "adsorbed" on the walls of the carboy.

As the oxidation of the sulphur dioxide to the trioxide was found to be a matter of hours rather than minutes, even with moisture present, it follows that the extremely rapid disappearance of the sulphur dioxide from the fumigating mixtures must necessarily be due to absorption by the plants and soil, and not to oxidation of the sulphur dioxide.

LABORATORY EXPERIMENTS TO DETERMINE THE EFFECT OF SULPHUR TRIOXIDE FUME OR SULPHURIC ACID MIST ON VEGETATION UNDER DIFFERENT HUMIDITY CONDITIONS.

In the field experiments at Vallejo, it was found that fumigation of barley plants with fumes from sulphur trioxide for periods of one to three hours produced no visible injury or any bleach similar to that produced by sulphur dioxide. Only when the foliage was wet and there resulted the formation of acid drops on the leaves did any injury whatever take place. In order to supplement this work, some few experiments were conducted in the laboratory to determine approximately the conditions under which injury will or will not be produced by sulphur trioxide.

The apparatus for this work was that used in the experiments to determine the rate of disappearance of sulphur dioxide from dilute mixtures. The fumigations were made in the 36-liter carboy from

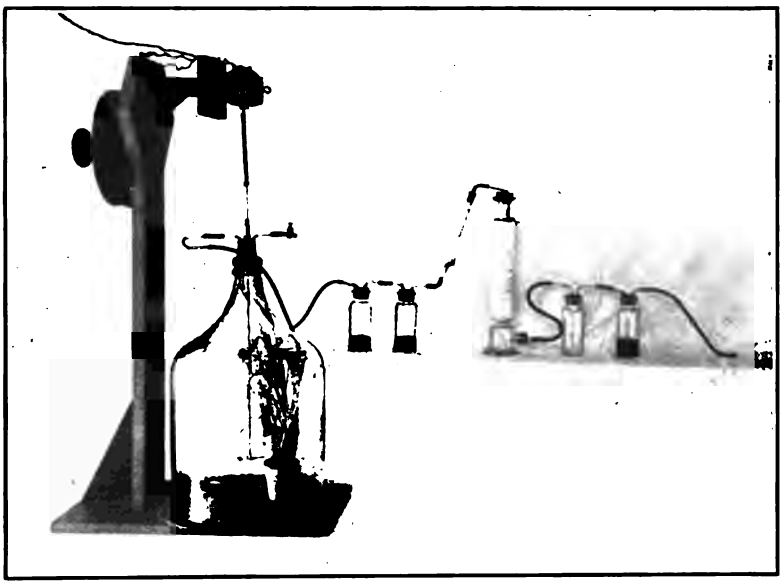
which the bottom had been removed. The barley experimented on was about 30 cm. high, and was transplanted into pots which could be placed on the ground-glass plate that formed the bottom of the carboy.

The sulphur trioxide fumes were produced by aspirating air through fuming sulphuric acid. The air for that purpose was first dried by aspirating it through sulphuric acid and a calcium chloride tower. Thus the fumes from the Nordhausen acid were nearly 100 per cent SO_3 as they were delivered into the carboy. However, from the vegetation and soil in the carboy, there was sufficient exudation of moisture to increase the atmospheric moisture content and thus to increase the moisture content of the fume, causing the formation of acid particles. Thus, in these experiments at no time did we have absolutely dry SO_3 fume or vapor.

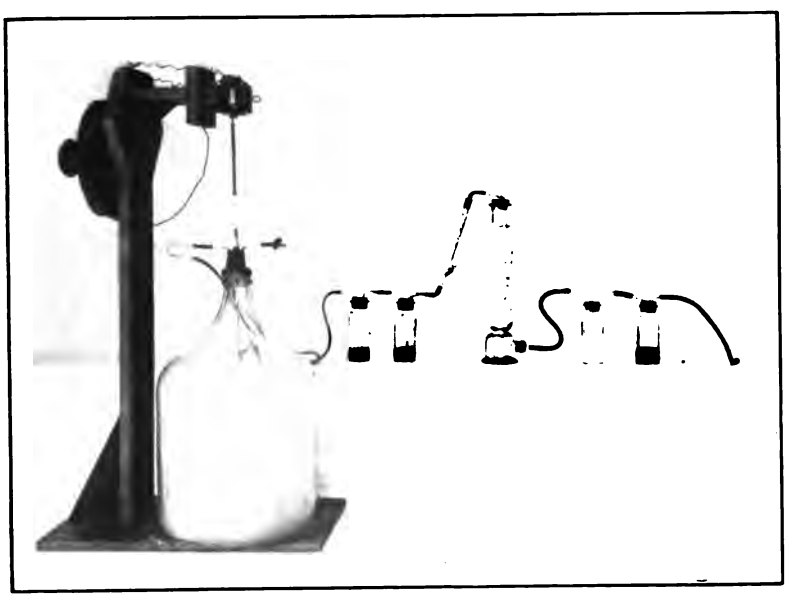
The concentrations of sulphur trioxide used in these fumigations were very high, varying between 2 and 2.5 grams SO_3 per cubic meter (equivalent to the conversion of 600 to 650 parts SO_2 per million parts of air by volume). These concentrations were determined by analyses of samples taken from the carboy. This concentration of fume was so dense that with any moisture present it was impossible to see the stirring fan or the vegetation in the carboy from the outside. Plate XXVI, *A*, shows the carboy with no fumes present. Plate XXVI, *B* shows the carboy with the sulphur trioxide, fumes present.

In these experiments it was found that under comparatively dry conditions—or in other words, when the conditions were the least favorable for the formation of acid particles—fumigations with SO_3 fume produced very little, if any, injury on the foliage of the barley.

In the fumigations that produced the least amount of injury or none at all there was maintained a steady stream of dry air carrying sulphur trioxide fume through the carboy. The suspension of the fume was aided by the revolution of the quartz fan in the carboy. Under these conditions fumigations with concentrated fume (2 grams SO_3 per cubic meter) lasting for three or four hours failed to produce more than very slight injury. Analysis of the air taken from the carboy during these fumigatious showed the presence of some sulphur dioxide (from 2 to 4 parts SO_2 per million), which was undoubtedly due to the presence of sulphur dioxide dissolved in the Nordhausen acid. The slight injury found on the foliage after these fumigations was that produced by this sulphur dioxide. The concentration of sulphur trioxide was equivalent to the conversion of 600 parts SO_2 per million. The bleaching that would have resulted from the application of this concentration of sulphur dioxide for a period of even less than five minutes would have been extremely severe; absolutely



A. CARBOY WITH NO SO_3 FUMES PRESENT.



B. CARBOY WITH SO_3 FUMES PRESENT.

all of the foliage would have been bleached. Yet in four hours' fumigation with this concentration of sulphur trioxide there was produced only very slight injury, which was characteristic of sulphur dioxide, and this was undoubtedly due to the sulphur dioxide in the mixture.

However, when the carboy was filled with the very dense fumes of SO_3, then closed, and the atmosphere in the carboy allowed to remain quiescent, the exudation of the moisture from the vegetation or the soil caused the formation of acid particles. These acid particles settled on the glass walls of the carboy and on the vegetation. In several fumigations the acid fumes or mist were practically settled out in about two hours. In these fumigations there was produced decided injury to the vegetation. The injury that was produced by these fumigations was dissimilar to that produced by sulphur dioxide. In the case of the acid injury there was an actual burning or drying up of the tissue of the foliage in the places where the drops of acid had stood. In some places a hole was eaten through the leaf. This effect of the SO_3 was distinctly corrosion or dessication, and the result did not resemble the bleach produced by sulphur dioxide.

In the case of severe injury produced by sulphur dioxide the bleach was greatest near the tip ends of the leaves or between the veins of the leaves. In the case of the sulphur trioxide or acid injury, however, the injury was confined to the portion where the drops of acid had stood. Thus the injury was found across the veins, and as frequently near the stems of the plants as at the tip end of the leaves.

The results of these few laboratory experiments confirmed the data obtained from the field experiments in showing that the injury that is produced by sulphur trioxide vapor, or dry SO_3 fume, is comparatively slight, if any takes place at all. Only when the sulphur trioxide unites with moisture to form acid particles does any injury result. Injury then can take place only when these acid particles are brought into contact with the leaves and are precipitated there. In this case the injury is confined solely to those spots where the acid particles are precipitated, and the injury is one of corrosion or dessication at those spots, not of bleaching.

DISAPPEARANCE OF SULPHUR DIOXIDE FROM DILUTE MIXTURES OF SULPHUR DIOXIDE WITH AIR.

By G. C. Bartells, jr.

INTRODUCTION.

The following investigations were carried on to confirm and explain, if possible, certain observations made in the field-fumigation experiments conducted by the Selby Smelter Commission. It was observed that when sulphur dioxide was introduced into a cabinet over barley plants a rapid disappearance of sulphur dioxide from the gas phase took place, and it was a question whether this was due to absorption by the plants or oxidation to sulphur trioxide.

This laboratory experimental work was divided into the following series:

1. The determination of the rate of disappearance of sulphur dioxide from a mixture of that gas and air in contact with (*a*) barley growing in black soil; (*b*) black soil alone; (*c*) various forms of green foliage cut from trees, vines, or shrubs.

2. The determination of the rate of disappearance of sulphur dioxide from a mixture of that gas and air held in a glass container (no vegetation or soil present) under various humidity and light conditions.

(*a*) Disappearance in diffused light in a dry atmosphere.

(*b*) Disappearance in diffused light in an atmosphere containing some moisture—about 50 per cent of saturation.

(*c*) Disappearance in diffused light and with slight excess of moisture present.

(*d*) Disappearance in direct sunlight in a dry atmosphere.

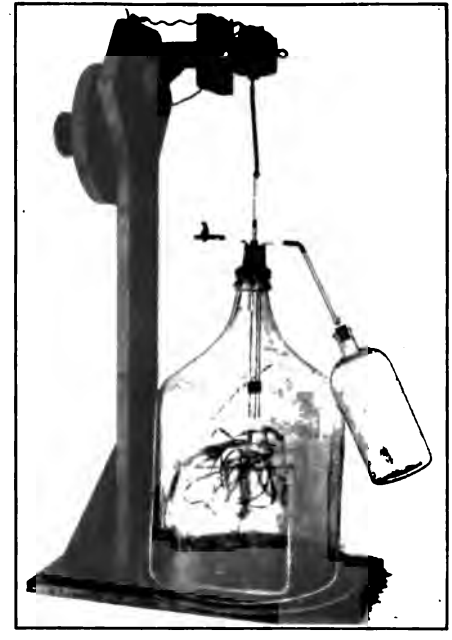
(*e*) The determination of the relative amounts of sulphur dioxide oxidized to the trioxide and that adsorbed on the walls of the glass container.

The first experiments to be considered are those of series 1, in which the disappearance of sulphur dioxide over various forms of vegetation was studied.

For these tests a 36-liter carboy (Pl. XXVII, *A*) from which the bottom had been removed was used as a hood. In the neck of the carboy was cemented a glass stopper, through which three holes

A. THIRTY-SIX-LITER CARBOY WITH BOTTOM REMOVED.

B. CARBOY HOOD WITH INLET TUBE CONNECTED.



C. PLANT SAMPLE IN CARBOY HOOD.

were drilled and glass tubes inserted. A tube extending just through the neck of the carboy was for the inlet of the air when samples were withdrawn. Another extending to about the center of the carboy was used for introducing the gas mixture and for withdrawing the samples for analysis. The third tube was for the purpose of holding the shaft of the fan by which the gas mixture was kept in circulation. This fan was made of quartz, and the top of the shaft was sealed with mercury to eliminate leakage. The fan was propelled by a small motor held above the carboy.

It is obvious that any change in the concentration of the gas inside the carboy was not due to any appreciable leakage.

In this group of experiments the carboy was set over the sample being treated. In the case of growing grain the soil and grain formed the bottom. If leaves of trees or leaves of grain were used, a glass that had been ground to fit the carboy was used to form the bottom.

METHOD OF INTRODUCING GAS MIXTURE.

A known concentration of sulphur dioxide gas was prepared by successively diluting the pure gas with air in a gas burette over mercury. A measured volume of this mixture was then introduced into the carboy through the long inlet tube (Pl. XXVII, *B*). The fan was then started to mix this volume with the air of the carboy.

In all cases the glass tip of the burette was butted against the glass entry tube of the carboy, so that the sulphur dioxide mixture would not be affected by the action of the rubber tubing. The outlet tube was left open, so that atmospheric pressure was maintained in the carboy while the mixture was being introduced.

METHOD OF SAMPLING GAS MIXTURE.

Two 2-liter acid bottles were fitted with test tubes of 50-c. c. capacity by means of rubber stoppers and glass tubing (Pl. XXVIII, *A*). One bottle was used as a "check," the other for withdrawing the sample.

This latter bottle, the "sample" bottle, for each test was evacuated by means of a pump to about one-half an atmosphere, thereby giving a sampling capacity of 1 liter.

Before the bottle was evacuated about 25 c. c. of weak iodine solution, to which a little starch indicator had been added, was shaken around in each bottle. The colors of these solutions were then compared, and if not identical, the solutions were brought to the same color and returned to their respective bottles. This operation was repeated until the solutions, after shaking, were identical in color. It is essential that a very pale blue color be used in the "check" to

titrate back to, or else small differences of color can not be determined accurately.

The evacuated sampling bottle was then connected with the carboy outlet tube, care being taken to butt the glass connections as close as possible. When the pressures in the carboy and sample bottle had equalized, the sample-bottle tube was closed with a screw clamp. The iodine solution was then run down into the bottle, and this bottle, as well as the "check," was vigorously shaken to insure complete contact of gas and iodine solution. If the solution was decolorized, sufficient iodine solution was added to bring it back to the color in the "check" bottle.

IODINE SOLUTIONS.

The iodine solutions were made up (approximately 0.0003 normal) in small quantities. They were frequently standardized against 0.001 normal arsenic trioxide, for they readily dissipate on standing, even in a dark place.

It was found that when 50 c. c. of starch solution was used in the bottles it was possible to detect a change in color brought about by the addition of 0.1 c. c. of this weak iodine solution. One-tenth of a cubic centimeter of this solution was equivalent to about 0.0003 c. c. of sulphur dioxide, which was equivalent, in a liter sample, to 0.3 part of sulphur dioxide per million parts by volume.

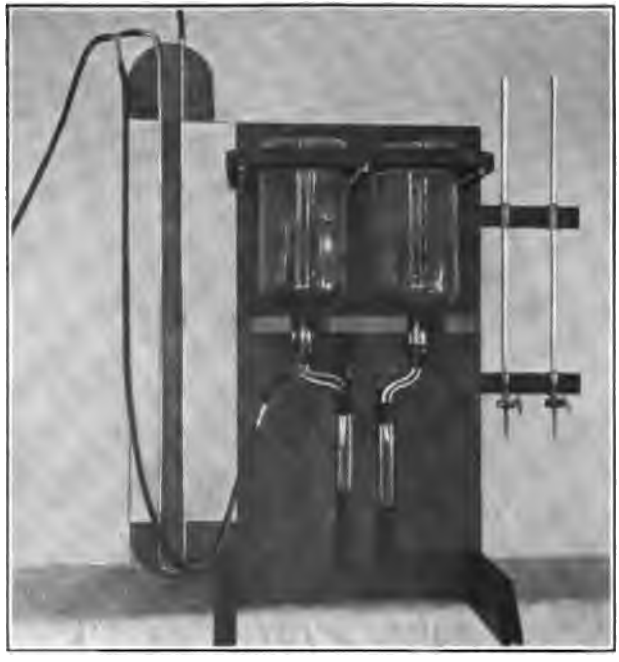
The strength of the sulphur dioxide mixtures was kept in the limits, 1 to 30 parts per million by volume, so as to be somewhat comparable to the strength of the mixtures used in the field work.

EXPERIMENTS IN SERIES 1.

TESTS WITH BARLEY PLANTS.

In Table 1 are given the results of a series of tests made with a stand of barley, which was 30 cm. high and about ready to head out. The barley had been replanted into a wooden box in good soil. Although it was not growing very vigorously, on account of the transplanting, yet it was green throughout.

From these results it is seen that about 75 to 80 per cent of the sulphur dioxide in a mixture of 28 parts SO_2 per million disappeared within about 2 minutes, and that in about 35 to 40 minutes the disappearance was practically complete. Considerable moisture was present, both in the soil and in the leaves, which no doubt aided materially in the disappearance of the sulphur dioxide.



A. APPARATUS FOR SAMPLING GAS MIXTURE FROM CARBOY.

B. THIRTY-SIX-LITER GLASS CARBOY USED IN FUMIGATION EXPERIMENTS.

TABLE 1.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in contact with barley growing in black soil.*

[1 c. c. iodine solution equivalent to 0.0037 c. c. SO_2; 20 c. c. of 5 per cent SO_2 mixture introduced.]

Time elapsed.	Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.	Relative humidity of the atmosphere.
	36-liter carboy.	1-liter sample.					
		Theoretical.	Actual.				
Minutes.	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*°C.*	*Per cent.*
0	272.0	7.6	.....	28.1	.....		
4	264.4	7.4	1.0	3.7	87		
6	257.0	7.2	.4	1.4	95	17	60
10	249.8	6.9	.2	.7	97		
15	242.9	6.7	.1	.4	99		
20	236.4	6.5	.0	.0	100		
0	272.0	7.6	.....	28.1	.....		
2	.....	7.4	1.8	6.7	76		
8	.....	7.2	1.0	3.7	86		
13	.....	6.9	.5	1.8	93	17	60
17	.....	6.7	.4	1.4	94		
21	.....	6.5	.2	.7	97		
26	.....	6.3	.1	.4	99		
0	272.0	7.6	.....	28.1	.....		
3	.....	7.4	1.8	6.7	76		
9	.....	7.2	.7	2.6	90		
14	.....	6.9	.5	1.8	93	17	60
18	.....	6.7	.2	.7	97		
22	.....	6.5	.1	.4	99		
0	272.0	7.6	.....	28.1	.....		
2	.....	7.4	1.7	6.3	77		
9	.....	7.2	.5	1.9	92		
15	.....	6.9	.2	.7	97	17	60
22	.....	6.7	.1	.4	99		
35	.....	6.5	.0	.0	100		
0	272.0	7.6	.....	28.1	.....		
2	.....	7.4	1.6	6.2	77		60
13	.....	7.2	.5	1.9	93	17	
30	.....	6.9	.2	.7	97		
40	.....	6.7	.1	.4	99		
45	.....	6.5	.0	.0	100		
0	272.0	7.6	.....	28.1	.....		
2	.....	7.4	1.4	5.2	81		
8	.....	7.2	.6	2.2	92		
13	.....	6.9	.3	1.1	96	17	60
17	.....	6.7	.2	.7	97		
27	.....	6.5	.1	.4	99		
38	.....	6.3	.0	.0	100		

TESTS WITH SOIL ALONE.

The next test was made with the soil in which the barley had grown, the barley plants simply being removed from the soil in the box. Therefore, the soil was the same in moisture as when the barley and soil were used together for a test.

The results of this test are given in Table 2, and show that the disappearance of the sulphur dioxide was not so rapid, nor does it completely disappear as with the barley plants and soil together. Within about two minutes approximately 60 per cent had disappeared, but even after two hours had passed there was still a residue of sulphur dioxide, indicating a condition of equilibrium between the sulphur dioxide content of the soil and that of the carboy atmosphere.

TABLE 2.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in contact with soil alone.*

[1 c. c. iodine solution equivalent to 0.0037 c. c. SO_2; 15 c. c. of 5 per cent SO_2 mixture introduced.]

Time elapsed.	Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.	Relative humidity of the atmosphere.
	36-liter carboy.	1-liter sample.					
		Theoretical.	Actual.				
Minutes.	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*°C.*	*Per cent.*
0	203.0	5.6	.....	20.8	.....		
2	197.4	5.5	2.2	8.1	60		
8	191.9	5.3	.6	2.2	89		
13	185.6	5.2	.4	1.4	92		
20	180.4	5.0	.3	1.1	94		
27	175.4	4.8	.2	.7	96	16	89
68	170.6	4.7	.1	.4	98		
110	165.9	4.6	.1	.4	98		
138	161.3	4.5	.1	.4	98		
157	156.8	4.3	.1	.4	98		
0	203.0	5.6	.....	20.8	.....		
2	.....	5.5	2.5	9.3	55		
7	.....	5.3	.8	2.9	89		
13	.....	5.2	.4	1.4	92		
19	.....	5.0	.4	1.4	92	16	89
31	.....	4.8	.3	1.1	94		
60	.....	4.7	.3	1.1	94		
113	.....	4.6	.1	.4	98		
140	.....	4.5	.1	.4	98		

TESTS WITH MISCELLANEOUS FOLIAGE, NOT GROWING.

A series of tests was next made with vegetation of various kinds, the results of which are given in the table following.

These samples of vegetation were obtained from the university campus and were treated the same day they were obtained, so that they were all green and vigorous. They were supported inside of the carboy on a glass stand, so that all parts of the sample were exposed to the action of the sulphur dioxide mixture (see Plate XXVII, *C*).

No appreciable damage resulting from the sulphur dioxide treatment was observed on any samples except the grapevine, and this was quite noticeable the following day especially, showing in a bleached condition of the whole leaf, accompanied by a decided wilting.

It is to be noted that in none of these tests was the disappearance of sulphur dioxide carried to completion, as in the test of the soil and barley combined, a small residue of the sulphur dioxide remaining in the air of the carboy.

TABLE 3.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in contact with various vegetable growths.*

[1 c. c. iodine equivalent to 0.0032 c. c. SO_2; 27 c. c. of 5 per cent SO_2 mixture introduced.]

ARBOR VITÆ BRANCHES (WEIGHT, 75 GRAMS).

Time elapsed.	Quantity of iodine solution required for— 35-liter carboy.	1-liter sample. Theoretical.	1-liter sample. Actual.	Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.	Relative humidity of the atmosphere.
Minutes.	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*°C.*	*Per cent.*
0	425.0	.....	.....	37.5	.....		
3	413.2	11.4	7.1	22.4	38		
10	401.8	11.2	5.7	18.2	49		
13	390.6	10.8	5.4	17.2	50		
20	379.8	10.5	3.6	11.5	65		
25	369.3	10.3	3.1	9.9	70		
45	359.0	10.0	2.0	6.4	80	17	72
50	349.0	9.7	1.7	5.4	83		
70	339.3	9.4	1.1	3.5	88		
75	329.9	9.2	.7	2.2	92		
135	320.7	8.9	.4	1.3	96		
140	311.8	8.7	.2	.7	98		

GRAPEVINE LEAVES AND STALK (WEIGHT, 55 GRAMS).

0	425.0	.....	.....	37.5	.....		
3	.....	11.4	6.5	20.8	43		
8	.....	11.2	2.2	7.1	80		
15	.....	10.6	1.2	3.9	89		
20	.....	10.5	.6	1.9	94	19	65
25	.....	10.3	.4	1.3	96		
45	.....	10.0	.3	1.0	97		
60	.....	9.7	.1	.3	99		
110	.....	9.4	.1	.3	99		

PEACH LIMB AND LEAVES WITH FRUIT (WEIGHT, 165 GRAMS).

0	425.0	11.8	.....	37.5	.....		
5	.....	11.5	5.8	18.5	50		
12	.....	11.2	2.1	6.7	81		
20	.....	10.9	1.4	4.5	87		
25	.....	10.5	.7	2.2	93		
30	.....	10.2	.6	1.9	94		
35	.....	10.0	.5	1.6	95	19	65
55	.....	9.7	.4	1.3	96		
130	.....	9.4	.3	1.0	97		
145	.....	9.2	.3	1.0	97		
165	.....	8.9	.2	.6	98		
180	.....	8.7	.2	.6	98		

APPLE LIMB AND LEAVES WITH SMALL FRUIT (WEIGHT, 100 GRAMS).

0	425.0	11.8	.....	37.5	.....		
5	.....	11.5	7.0	22.0	39		
10	.....	11.2	4.7	15.0	58		
15	.....	10.9	4.0	12.8	63		
20	.....	10.5	3.3	10.5	68		
30	.....	10.2	1.4	4.5	86	19	65
40	.....	10.0	.8	2.6	92		
60	.....	9.7	.4	1.3	96		
65	.....	9.4	.4	1.3	96		
80	.....	9.2	.2	.6	98		
95	.....	8.9	.2	.6	98		

EXPERIMENTS IN SERIES 2.

All of the following tests were carried out in a 46-liter glass carboy, with the bottom left in, so that there was a complete glass surface exposed to the action of the gas mixtures (Pl. XXVIII, *B*). The neck was stoppered with glass, and the inlets and outlets were similar to those in the carboy described above.

The method used for drying out this carboy was as follows: It was thoroughly washed out with distilled water and drained, set upside down on a tripod, and, through a two-hole stopper in the neck, dry air was blown through the carboy for about three hours.

This air was dried by passing compressed air through potassium permanganate, calcium chloride, and sulphuric acid towers in series. Just before passing into the carboy, the air was heated to accelerate the evaporation of the moisture present in the carboy. As an additional means of drying, air dried by calcium chloride was drawn through in sufficient quantity to displace all of the air in the carboy.

The method of introducing the sulphur dioxide mixture was the same as described for previous experiments. The method of withdrawing the sample was the same, with this addition, that the air that was drawn in to replace the sample was drawn through a calcium chloride tower to maintain the dry condition where such was desired.

The first test carried on was to determine the action of the sulphur dioxide mixture under the dry conditions, brought about as described above, in the diffused light of a laboratory.

The figures in Table 4, giving the results of the tests, show that after a considerable period there was a slight disappearance of sulphur dioxide. No data are available for the interval between 4½ hours and 20 hours, so that the disappearance may be more gradual than is indicated in the table.

TABLE 4.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in a dry carboy in diffused light.*

[1 c. c. iodine solution equivalent to 0.0031 c. c. SO_2.]

17 C. C. OF 5 PER CENT SO_2 MIXTURE INTRODUCED.

Time elapsed.	Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.
	46-liter carboy.	1-liter sample.				
		Theoretical.	Actual.			
H. m.	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*°C.*
0	272.0	6.0	6.0	22	.....	
5	266.0	5.8	5.8	.....	0	
20	260.2	5.7	5.7	.....	0	
40	254.5	5.5	5.5	.....	0	
1 0	249.0	5.4	5.4	21	0	16
2 15	243.6	5.3	5.3	20	0	
45	238.3	5.2	5.2	.....	0	
3 40	233.1	5.1	5.1	19	0	
4 25	228.0	5.0	5.0	18	0	
22 0	223.0	4.8	4.4	16	8.3	
40	218.2	4.7	4.3	.....	8.5	
23 25	213.5	4.6	4.2	.....	8.7	
24 0	208.9	4.5	4.1	15	11.0	15
28 30	204.4	4.4	4.0	.....	9.1	
29 30	200.0	4.3	3.8	14	11.5	

30 C. C. OF 6 PER CENT SO_2 INTRODUCED.

0	580.0	12.6	12.6	39	.....	
10	567.4	12.3	12.2	.....	.....	
15	555.1	12.0	12.0	.....	.....	
25	543.0	11.8	11.8	.....	.....	16
30	531.2	11.5	11.6	.....	.....	
1 0	520.7	11.3	11.3	35	.....	
20	509.4	11.0	11.0	.....	.....	
40	498.4	10.8	10.7	.....	.....	
20 0	487.6	10.6	9.7	30	8.5	.....
5	477.0	10.3	9.5	.....	7.8	.....
15	465.7	10.1	9.2	.....	8.9	.....
40	455.6	9.9	9.0	28	9.1	.....

The following test was carried on in the carboy in an atmosphere 50 per cent saturated with water vapor, the carboy standing in diffused light. The distinctive feature of this following test was the addition of sufficient water to produce 50 per cent saturation at the temperature obtaining in the carboy.

As the disappearance of the sulphur dioxide progressed, its concentration in the carboy was thereby lowered, so that an additional amount of sulphur dioxide mixture had to be added to bring the gas to a suitable strength, as is shown in Table 5 following. This test was carried on at intervals extending over a week end, and some of the intermediate figures are wanting, but the action of the sulphur dioxide mixture under these conditions is clearly indicated from the figures given.

It is to be noted that when a sample for analysis was withdrawn, the air drawn in to replace it was taken direct from the outside air, so that the humidity in the carboy was slightly increased, for at all times

the humidity of the outside air was above 50 per cent. A fuller discussion of this is made in the conclusions.

From the data given it is evident that the rate of disappearance under these conditions of semisaturation is much greater than under dry conditions. The figures for the percentage of disappearance are higher in the first test (48 hours), but it is to be noted that the humidity of the air during this test was high, so that the air drawn in, carrying in all about 0.25 gram of moisture, raised the humidity to about 75 per cent inside the carboy toward the last part of the test.

TABLE 5.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in a carboy, the air being 50 per cent saturated with moisture.*

14.6 C. C. OF 5 PER CENT SO_2 MIXTURE INTRODUCED.

[1 c. c. of iodine solution equivalent to 0.0037 c. c. of SO_2.]

Test.	Time elapsed.		Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.	Relative humidity of atmosphere.
			46-liter carboy.	1-liter sample.					
				Theoretical.	Actual.				
	H.	*m.*	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*° C.*	*Per cent.*
A	0	0	200.0	4.4	.....	16	0.0		
		5	195.6	4.3	4.2	.....	2.3		
		20	191.4	4.2	4.0	.....	4.2		
	2	0	187.3	4.1	3.7	14	9.7		
	3	30	183.3	4.0	3.6	.....	10.0	18	98
		50	179.3	3.9	3.5	.....	10.1		
	4	40	175.4	3.8	3.4	13	10.5		
	22	0	171.6	3.7	3.2	12	13.5		
		20	167.9	3.6	3.1	.....	14.0		
20 C. C. OF 5 PER CENT SO_2 MIXTURE WAS ADDED AT THIS TIME.									
	22	25	[a] 272.0	9.6	8.2	[b] 31	14.6		
		35	426.7	9.3	8.0	.....	14.0		
		45	417.4	9.1	7.8	.....	14.3		
	47	0	408.3	8.9	6.2	23	30.5		
		15	399.4	8.7	6.1	.....	29.5	18	98
		25	390.7	8.5	5.7	.....	30.0		
		30	382.2	8.3	5.7	.....	31.5		
	48	0	373.9	8.1	5.6	20	31.0		
30 C. C. OF 5 PER CENT SO_2 MIXTURE INTRODUCED. [1 c. c. iodine solution equivalent to 0.00374 c. c. SO_2.]									
B	0	0	396.0	8.7	8.7	33	0.0		
		5	387.3	8.4	8.4	.....	.0		
		30	378.9	8.2	8.1	.....	1.2		
		35	370.7	8.0	7.8	.....	2.5		
	2	25	362.7	7.9	7.4	28	6.3		
		30	354.8	7.7	7.1	.....	7.8	16	70
	3	0	347.1	7.5	6.9	26	8.0		
		35	339.6	7.4	6.9	.....	6.8		
		40	332.2	7.3	6.7	.....	8.2		
	4	30	324.9	7.0	6.4	24	8.6		
		40	317.9	6.9	6.3	.....	8.7		
		50	311.0	6.8	6.1	.....	10.1		
	22	0	304.2	6.7	5.8	22	13.4		
	23	45	294.4	6.4	5.3	20	17.2	17	60
	24	5	281.7	6.2	5.1	19	17.5		
	25	30	275.5	6.0	5.0	.....	16.8		
	46	20	263.6	5.8	4.4	16	24.0	19	80

[a] Actual quantity added; theoretical quantity needed, 164.3 c. c. [b] Actual; theoretical, 36 parts.

The following tests were carried on with the air in the carboy fully saturated, this being accomplished by introducing about 20 c. c. of water, which was well shaken to thoroughly distribute the moisture about the carboy.

All of these tests were carried on over a period of about 20 hours, and it is to be noted that the first 50 per cent of sulphur dioxide disappeared very rapidly in about the first hour. Also, that the rate of disappearance of the following 40 per cent was much greater than in the test in which the air in the carboy was in a semisaturated condition.

The amount of water introduced into the carboy was in excess of the amount needed to saturate the air in the carboy, the calculated amount being about 1 c. c. This excess of water in the carboy, without doubt, had a solvent action on the sulphur dioxide in the gas mixture, which, to some small degree, accounts for the initial rapid disappearance of the sulphur dioxide. However, the solubility of sulphur dioxide from dilute mixtures is very low, so that as a direct solvent of the gas the water would act to only a small degree.

TABLE 6.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in a carboy, the air being 100 per cent saturated with moisture.*

25 C. C. OF 5 PER CENT SO_2 MIXTURE ADDED.

[1 c. c. iodine solution equivalent to 0.0037 c. c. SO_2.]

Test.	Time elapsed.		Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.	Relative humidity of atmosphere.
			46-liter carboy.	1-liter sample.					
				Theoretical.	Actual.				
	H.	*m.*	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	° *C.*	*Per cent.*
A	0	0	335.0	7.3	.....	27	.....		
		3	335.0	7.3	3.9	14	47		
		5	327.7	7.1	3.3	.....	53		
		15	320.6	6.9	2.9	.....	58		
		22	313.7	6.8	2.6	.....	62		
		40	306.9	6.7	2.3	.....	66	18	98
	1	0	300.2	6.5	2.3	9	65		
	2	0	293.7	6.4	2.0	7	69		
		10	287.3	6.3	1.9	.....	70		
	19	0	281.0	6.1	1.0	4	84		
	20	0	263.0	5.7	.6	2	90	[a]17	94

[a] 20 c. c. of water was introduced into the carboy and shaken around well to give it a saturated atmosphere at this temperature.

TABLE 6.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in a carboy, the air being 100 per cent saturated with moisture*—Contd.

30 C. C. OF 5 PER CENT SO_2 MIXTURE INTRODUCED.

[1 c. c. iodine equivalent to 0.0031 c. c. SO_2.]

Test.	Time elapsed.	Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.	Relative humidity of atmosphere.
		46-liter carboy.	1-liter sample.					
			Theoretical.	Actual.				
	H. m.	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*° C.*	*Per cent.*
B	0 0	484.0	10.5	.....	32	.....		
	5	484.0	10.5	6.5	.....	38		
	10	473.5	10.3	6.3	.....	39		
	15	463.2	10.1	6.0	.....	40		
	20	453.1	9.8	5.8	.....	41		
	30	443.3	9.6	5.5	.....	43	17	88
	45	433.6	9.4	5.0	.....	47		
	1 5	423.2	9.2	4.2	13	55		
	20	414.0	9.0	4.0	.....	56		
	2 0	405.0	8.8	3.5	11	60		
	10	396.2	8.6	3.4	.....	60		
	19 0	387.6	8.4	.8	3	90		
	20 0	363.0	7.8	.4	1	95	[a] 17	82
C	0 0	484.0	10.5	.....	27	.....		
	5	484.0	10.5	7.2	.....	33		
	10	473.5	10.3	6.6	.....	36		
	15	463.2	10.1	5.0	.....	50		
	20	453.1	9.8	5.0	.....	49		
	30	443.3	9.6	4.6	.....	52		
	40	433.6	9.4	4.4	.....	53	[a] 18	65
	1 0	423.2	9.2	4.0	12	56		
	50	414.0	9.0	3.5	.....	61		
	2 0	405.0	8.8	2.5	8	72		
	15	396.2	8.6	2.2	.....	72		
	19 15	379.2	8.2	1.0	.....	87		
	20 0	363.0	7.9	.9	3	89		

[a] 20 c. c. of water was introduced into the carboy and shaken around well to give it a saturated atmosphere at this temperature.

The last series of tests was made with the carboy standing in the direct sunlight on a platform outside of the laboratory.

The carboy was dried out as previously described, and all the air drawn in when samples were withdrawn was drawn through calcium chloride to preserve the dry condition in the carboy. The table (Table 7) shows that each of these tests extended over a certain number of hours, the hours being continuous from the time the test was started. It is to be noted, however, that the actual number of hours of direct sunlight is much less than the total number of hours given in the table. The number of hours of total direct sunlight are given for each test in a note below each test. The prolonged action of the direct sunlight on the sulphur dioxide mixture does not cause the disappearance of the sulphur dioxide to increase very much after a certain point has been reached. For instance, the additional sunlight in test B, an excess of nine hours over test A, has not increased the percentage disappearance to any appreciable extent.

TABLE 7.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in a carboy standing in direct sunlight.*

30 C. C. OF 6 PER CENT SO_2 MIXTURE ADDED.

[Atmosphere in the carboy considered dry; 1 c. c. iodine solution equivalent to 0.0030 c. c. SO_2.]

Test.	Time elapsed.		Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.
			46-liter carboy.	1-liter sample.				
				Theoretical.	Actual.			
	H.	*m.*	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*°C.*
A[a]		0	615.0	13.5	.....	42	.....	.....
		5	615.0	13.5	13.3	.....	1	26
		15	601.5	13.4	13.2	.....	1	27
		30	588.1	13.3	13.1	.....	2	28
	1	5	574.8	12.6	12.3	38	2	31
		15	562.2	12.4	12.0	.....	3	31
		25	549.8	12.3	11.7	.....	5	32
		45	537.5	12.2	10.8	.....	12	36
	2	0	525.4	12.1	10.5	33	12	37
		5	513.3	12.0	10.4	.....	13	38
		30	501.3	11.7	10.2	.....	13	39
	3	0	489.6	11.4	9.5	.....	18	38
		20	478.2	11.2	9.2	.....	18	38
		40	467.0	10.9	9.1	.....	18	37
	4	5	456.1	10.5	8.8	29	16	36
	4	20	445.6	10.2	8.5	.....	17	35
	20	45	435.4	9.6	8.0	25	17	18
	24	0	371.7	8.3	6.2	19	25	29
	26	0	324.7	7.2	4.9	15	32	27
	44	15	296.9	6.5	4.1	13	37	17
	45	0	284.1	6.2	4.0	12	35	18

30 C. C. OF 5 PER CENT SO_2 MIXTURE INTRODUCED.

[Atmosphere in carboy considered dry; 1 c. c. iodine solution equivalent to 0.00381 c. c. SO_2.]

B[b]		0	386.0	8.4	8.4	32	0	18
		5	377.6	8.2	8.2	.....	0	18
		10	369.4	8.0	7.9	.....	1	18
		40	361.4	8.0	7.6	.....	5	27
		50	353.4	7.9	7.4	.....	6	27
	1	0	345.5	7.7	7.2	27	6	27
		10	337.8	7.6	7.1	.....	7	27
		20	330.2	7.4	7.0	.....	6	27
		30	322.8	7.2	6.8	.....	6	27
		40	315.6	7.0	6.6	.....	6	27
	2	40	308.0	6.9	6.4	24	7	30
		45	301.0	6.7	6.1	.....	9	30
		50	294.4	6.6	6.0	.....	9	30
	25	10	287.8	6.4	5.2	20	19	32
	28	0	251.1	5.7	4.6	17	19	36
(c)	47	20	276.0	6.0	4.1	14	31	29
	97	20	258.3	5.7	3.7	12	35	29
	100	0	221.3	4.8	3.0	10	38	29

30 C. C. OF 5 PER CENT SO_2 MIXTURE INTRODUCED.

[Atmosphere in carboy considered dry; 1 c. c. iodine solution equivalent to 0.00308 c. c. SO_2.]

C[d]		0	480.0	.....	.....	.....	.....	.....
		5	480.0	10.4	10.5	32	0	19
		10	469.6	10.3	10.2	.....	1	21
		25	459.3	10.1	9.6	.....	5	25
		30	449.2	10.0	9.4	.....	6	26
		35	439.0	9.5	8.5	.....	6	27
		45	429.5	9.3	8.6	.....	7	27
		55	420.2	9.1	8.6	.....	6	28
	1	5	411.1	8.9	8.4	26	6	28
	22	20	402.2	8.4	6.6	20	21	20
	24	5	354.3	7.3	5.8	18	20	28
	25	0	330.0	6.8	5.4	16	21	27

[a] Total of eleven hours of direct sunlight.
[b] Total of 20 hours of direct sunlight.
[c] New iodine solution used here—1 c. c. equivalent to 0.0033 c. c. SO_2.
[d] Total of 4 hours of direct sunlight.

TABLE 7.—*Results of experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in a carboy standing in direct sunlight*—Continued.

28 C. C. OF 5 PER CENT SO_2 MIXTURE INTRODUCED.

[Atmosphere in carboy considered dry; 1 c. c. iodine solution equivalent to 0.0037 c. c. SO_2.]

Test.	Time elapsed.	Quantity of iodine solution required for—			Parts of SO_2 per million.	Proportion of SO_2 lost.	Carboy temperature.
		46-liter carboy.	1-liter sample.				
			Theoretical.	Actual.			
	H. m.	*C. c.*	*C. c.*	*C. c.*		*Per cent.*	*°C.*
D[a]	0	378.5	8.2	.....	31	.....	.....
	5	378.5	8.2	8.1	.....	1.1	20
	10	370.3	8.1	8.0	.....	1.1	21
	15	362.2	7.9	7.8	.....	1.2	23
	30	354.3	7.8	7.4	.....	5.1	28
	40	346.4	7.7	7.1	.....	7.8	28
	45	338.6	7.6	7.1	.....	6.6	29
	1 20	330.9	7.5	6.8	25	9.3	31
	35	323.4	7.3	6.7	.....	8.3	31
	2 0	316.1	7.1	6.5	24	8.5	31
	20	309.0	7.0	6.4	.....	8.6	30
	35	302.0	6.8	6.2	.....	8.8	30
	20 0	295.2	6.4	5.8	21	9.4	18

[a] Total of 2 hours of direct sunlight.

The disappearance of the sulphur dioxide from the gas mixtures in the glass carboy was doubtless due for the greater part to oxidation and adsorption on the walls of the glass carboy.

A strong adsorptive property is characteristic of glass surfaces, and the degree to which adsorption is carried varies with the amount of moisture in the air in contact with the glass surface. In these tests the adsorption takes place on a glass in which there is more or less available alkali present, which, with the moisture, would form an alkaline solution. This has the property of fixing the sulphur dioxide. The greater the amount of moisture present, the greater the amount of sulphur dioxide adsorbed, and the greater the rate of its adsorption. It is evident that some such action as this takes place, from the fact that the amount of moisture present in most of these tests is not sufficient to account for a simple solution of the sulphur dioxide.

The following table presents some of the data obtained in the two groups of experiments, first, in a dry atmosphere in the direct sunlight, and second, in a moisture-saturated atmosphere in diffused light.

I wish to state that these data have not been checked sufficiently to be final, and should be taken only as indicating the possible action that takes place.

Data obtained in experiments to determine rate of disappearance of SO_2 from a mixture of SO_2 and air in a carboy under differing conditions.

AIR IN CARBOY CONSIDERED DRY.

Sulphur introduced as SO_2.	Sulphur in washings as $BaSO_4$.	Sulphur withdrawn for analysis, calculated (1—2).	Sulphur withdrawn for analysis.	Sulphur washed out and titrated against iodine.	Sulphur as residual SO_2 in carboy.	Sulphur absorbed, calculated (5—6).	Sulphur washed out as SO_3, calculated (2—5).
1	2	3	4	5	6	7	8
0.00263.....	0.00120	0.00143	0.00124	0.00093	0.00079	0.00014	0.00027
.00214.....	.00146	.00068	.00060	.00129	.00110	.00019	.00017
.00205.....	.00165	.00040	.00038	.00135	.00132	.00003	.00030

AIR IN CARBOY SATURATED AND IN DIFFUSED LIGHT.

0.00178.....	0.00120	0.00058	0.00013	0.00090	0.00015	0.00085	0.00030
.00215.....	.00165	.00050	.00024	.00130	.00010	.00130	.00035
.00215.....	.00169	.00046	.00023	.00104	.00018	.00086	.00065

The values in column 3 are calculated simply as the difference between the total sulphur introduced as sulphur dioxide and the total sulphur weighed as barium sulphate from the washings. Those in column 4 are obtained by actual titration, and it is to be noted that they are lower. This discrepancy can be explained by considering the values of sulphur from barium sulphate as low, which might occur if the solution in which it was precipitated was strongly acid, and by taking into account also the expansion of the air inside the carboy in the first set of tests, in which the action of direct sunlight was studied. As a matter of fact, as shown in the tables, the increase in temperature inside the carboy ranged from 20° to 35°, which would increase the volume of the gas mixture about 5 per cent, or about 5 per cent of the sulphur dioxide in the mixture was lost, thereby giving low values for column 4. However, for these same values in the tests following in a saturated atmosphere, this expansion loss does not apply. If we consider, however, that the sulphur dioxide in the moist atmosphere was oxidized into sulphur trioxide to a greater degree than in the dry atmosphere, as is indicated by the data in column 8, and that in this condition as a fume or a gas it is withdrawn with the samples and lost, then we can account for a very small part of the discrepancy shown (for it would result in low total sulphur), but the best explanation is that already given, of low barium sulphate weights.

The difference between columns 5 and 6 is indicated as due to adsorption of part of the sulphur dioxide, which is fixed on the surface of the glass by means of the alkali, as noted before.

It is to be noted that in the first set of results in the dry carboy the percentages of the amount of sulphur dioxide adsorbed with respect to the amount introduced do not agree with each other. This is explained by the fact that the amount of adsorption varies with the amount of moisture present, and these carboys supposedly dried by the same method actually contained varying amounts of moisture, as is indicated by this apparent discrepancy.

The percentage of adsorption varies in the tests in the dry carboy from 1.5 to 8.7, while in the tests in the moisture-saturated carboy they agree more closely, averaging about 47 per cent.

The values for the sulphur as sulphur trioxide are to be taken as relative results rather than as actual, for the reason that there is the possibility of the barium sulphate determinations being low, and it is from these that the sulphur trioxide values are calculated.

That the actual oxidation of sulphur dioxide into sulphur trioxide takes place more rapidly in moist conditions than in dry is evidenced by the somewhat higher results in column 8, the values in the dry condition averaging about 11 per cent, while those in the moist averaged about 21 per cent of the total introduced as sulphur dioxide into the carboy.

I would like to say in conclusion that these experiments were started primarily with the idea of ascertaining the amount of disappearance, and also the rate of disappearance, and that the data giving the cause for the disappearance are not comprehensive enough to be final.

SUMMARY.

From the data obtained in these tests it is evident:

(*a*) That when a mixture of sulphur dioxide and air was introduced into a closed glass carboy and brought into contact with green vegetation, the sulphur dioxide disappeared very rapidly and almost completely. This was due in great part to the simple absorption of the sulphur dioxide by the live plant; to a small degree, to the oxidation of sulphur dioxide in an excess of moist air, and also to that peculiar property of the glass by which it adsorbs the moisture of the air and fixes the sulphur dioxide thereby.

(*b*) That when a mixture of sulphur dioxide and air was left standing in a glass container for a considerable period in a dry atmosphere in diffused light, there was a disappearance of sulphur dioxide—about 10 per cent in about 30 hours.

This was due in part to the oxidation of the sulphur dioxide that takes place on long standing in contact with air, and partly to loss by diffusion. As the carboy stood over night, the gas mixture cooled, and thereby contracted considerably, in which operation the gas mixture was diluted with air to a greater or less extent. Also, in this

test part of the disappearance could be attributed to the adsorptive property of the glass, for although considered dry, yet there was no doubt some trace of moisture present, which would readily be adsorbed by the glass surface, as has already been discussed above.

(*c*) When sulphur dioxide was mixed with air containing moisture to the point of 50 per cent saturation, the rate of disappearance was much greater than in the dry air alone. This was due for the most part to the adsorption of the sulphur dioxide on the glass surface.

(*d*) When sulphur dioxide was mixed with air containing moisture to the point of 100 per cent saturation, the rate of disappearance of the sulphur dioxide was much greater and the disappearance more nearly complete than under any other conditions. In this test, also, the increased amount of moisture accounts, by the neutralizing effect of alkaline from the glass, for a great deal of the disappearance, and also the greater rate of disappearance.

(*e*) When a mixture of sulphur dioxide and air was exposed to the action of direct sunlight, a gradual disappearance of the sulphur dioxide took place, the rate of its disappearance being greatest at those times when the temperature in the carboy was highest. This fact would preclude to a large extent the simple solution of sulphur dioxide by any moisture present, for as the temperature of water ncreases, the solubility of sulphur dioxide decreases to a marked degree. A part of the sulphur dioxide was adsorbed, the amount varying with the amount of water present.

(*f*) In all of these tests both oxidation and absorption took place. In a moist atmosphere both of these took place to a greater degree than in a dry atmosphere.

INVESTIGATIONS OF THE GASES FROM THE DWIGHT & LLOYD SINTERING MACHINES AT THE SELBY SMELTER.

By A. E. Wells.

In the general discussion concerning the conditions in and around the Selby smelter it was shown that all the solid emanations from the furnaces—that is, flue dust and fume—are now removed from the waste gases by filtration through bags. The only emanation that now contaminates the atmosphere is the sulphur dioxide from the sintering machines.

These investigations have been made for the purpose of determining the possibility of reducing the amount of this sulphur dioxide output. A reduction of the sulphur dioxide output can be accomplished either by diverting to an acid plant some of the sulphur-bearing material for the extraction of the sulphur before it is received at the Selby smelter or by reducing, oxidizing, or otherwise recovering the sulphur dioxide produced by the roasting of the material now received.

As stated in another part of this report, the sulphur-bearing material received at the smelter may be classified as follows:

1. California iron-sulphide ores.
   a. Raw sulphide ores.
   b. Preroasted sulphide ores.
2. High-grade gold and silver concentrates and lead-bearing iron sulphide ores.
3. Products from lead concentrators.
   a. Concentrates.
   b. Middlings.
   c. Slimes.

During the last year there was a very small tonnage of the California raw sulphide ores roasted at the Selby smelter. Practically all this material is roasted at an acid plant of the General Chemical Co. for the production of acid, and the roasted ore is then sent to the Selby smelter. No raw sulphides are being used in the charge for the purpose of furnishing fuel for the sintering of the charges on the sintering machines. At no time in 1913 was the amount of the raw sulphides on the charge equal to 10 per cent.

The other classes of sulphur-bearing material can not be handled economically at any acid-manufacturing plant under the present acid practices, because of the rather low sulphur content and of the danger of high metal losses in the treatment.

Thus, as the smelter is not roasting material that could be roasted economically elsewhere, the problem facing us is not so much to determine the possibility of further reducing the sulphur to be roasted as it is to prevent the sulphur dioxide resulting from the present roasting conditions being discharged into the atmosphere. We have attempted to determine whether or not the sulphur dioxide resulting from the oxidation of this sulphur can be treated economically and practically in such a manner that a commercial by-product can be obtained therefrom.

In order to treat these gases successfully in any one of the several possible methods of recovery it is necessary that the concentration of the sulphur dioxide in the gases should be at least 6 per cent SO_2. Thus, before any possible method for the recovery could be considered it was essential to know how great a concentration of sulphur dioxide could be obtained in the gases from the Dwight & Lloyd sintering machines. During January and February, 1914, our work was entirely along this problem, namely, determining the concentration of sulphur dioxide that could be attained and maintained under different charge and operating conditions.

PRELIMINARY STUDY OF CHARGES AND OPERATING CONDITIONS AT SINTERING MACHINES.

Before any experimental work at the machines was started a careful study was made of the character of the material sintered and of the variations existing in the chemical composition and physical nature of the charges and sintered products. The records of the sintering department of the plant were opened to us for that purpose, and we were given all the information at hand concerning the "sintering qualities" and characteristics of the various kinds of charges.

It may be well to point out some of the more important features of the charge conditions before proceeding further, so that the significance of some of the data obtained in the tests may be fully appreciated.

Table 1, giving the monthly average percentages of lead and sulphur in the charge during the year 1913, shows that the amount of lead varied between 20 and 33 per cent and the sulphur between 12 and 14.3 per cent. Not only did the charge composition vary from month to month as shown, but there were even wider variations during the month, as indicated in Table 2.

TABLE 1.—*Monthly average percentages of lead and sulphur in charge in sintering machines during 1913.*

Month.	Proportion of charge.		Month.	Proportion of charge.	
	Lead (Pb).	Sulphur (S).		Lead (Pb).	Sulphur (S).
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
January	20.0	12.9	July	28.8	12.8
February	26.3	12.3	August	25.5	12.2
March	32.6	12.5	September	24.0	12.6
April	33.0	12.0	October	22.0	14.3
May	31.3	12.8	November	26.0	14.2
June	32.9	12.2	December	26.8	13.2

TABLE 2.—*Data showing variations in lead and in sulphur content of sintering-machine charges during certain months in 1913.*

Month.	Proportion of lead in charge.			Proportion of sulphur in charge.		
	Average.	Maximum.	Minimum.	Average.	Maximum.	Minimum.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
September	24.0	36.0	16.0	12.6	14.6	11.0
October	22.0	27.0	18.0	14.3	16.8	12.2
November	26.0	36.0	20.0	14.2	15.8	13.0
December	26.8	38.0	22.0	13.2	14.3	12.0

As was predicted and later determined, the variations in the chemical composition of the charge, within wide limits, were not so important in affecting the gas concentration as were the differences in the physical condition of the charge.

A review of the monthly statements for 1913 shows many variations in the proportions of the charge constituents. The average mixtures during April, September, and October are given in Table 3, showing very marked differences in the relative proportions of the constituents.

TABLE 3.—*Average mixtures of charges in sintering machines during each of three months in 1913.*

Material sintered.	April.	September.	October.
	Per cent.	*Per cent.*	*Per cent.*
Concentrates	64.1	34.4	50.2
Raw sulphurets	3.7	9.3	1.9
Preroasted ore	10.7	18.0	35.2
Siliceous tailing	.....	8.4	.....
Crushed quartz	7.3	9.8	6.6
Matte	10.9	8.9	5.6
Flue dust	3.3	11.2	0.5

These figures do not show completely the degree to which the physical nature of the charge has varied, for under the title "Concentrates" is included a wide variety of material ranging in size from coarse lumps of galena (nut size) to very fine impalpable slimes. However, as the greater proportion of the constituents of the charges

is made up of material of approximately the same fineness, it was considered practical to maintain a fairly even physical condition of of the charge by crushing finer the coarser lead concentrates, the jig products, and the matte, and distributing the slimes more equally over all charges. That this would result in more uniform roasting conditions and consequently produce a better product was admitted by the metallurgists of the smelter. It was thought that the ordinary minor variations in the physical condition of the charges that would then be encountered would not cause any very wide differences in the gas concentration.

In order to study the effect of these charge and operating conditions on the gas concentration, and to determine the condition under which the highest concentration or sulphur dioxide could be obtained, the tests to be described in this report were made.

As No. 3 machine was the most recently built, and consequently the contact surfaces of the palettes and wind boxes were the least worn and thus tightest against air leakage, this machine was used in the work. The roasting area of the machine is about 21 feet long, and beneath this length there are two wind boxes into which the air and gases are drawn through the grate bars. An outlet pipe from each box is connected to a pipe leading to a Sirocco fan which maintains a partial vacuum of 6 inches to 12 inches water in the boxes.

PRELIMINARY STUDY OF GAS CONCENTRATION.

To determine the effect of any change of charge or operating conditions upon the general roasting process, it was necessary to determine the sulphur dioxide content of the gases that were actually drawn through the charge at several points along the grate. By these tests also, the points of maximum and minimum concentration were determined, which gave us the basis for subdividing the wind boxes and for the recirculation of some of the gases.

For these determinations a series of 10 holes three-eighths of an inch in diameter were drilled through the side of the wind boxes in a line 8 inches below the line of palettes. By use of a suitable length of glass tubing inserted through these holes and bent upward so that the intake was just below the palettes, a sample of the gases coming through the grates over the holes could be taken out and analyzed. The holes were placed at distances of 1, 3, 5, 7, 9, 12, 14, 16, 18, and 20 feet beyond the ignition point.

Table 4, in which is given the average sulphur dioxide content of the gases coming through the grates at the several points under average charge and operating conditions, shows that the maximum sulphur dioxide concentration was obtained at a point 7 feet from the ignition point, and that for a distance of 7 feet extending from a point 3 feet beyond the ignition point to the end of the first wind

box, the gases averaged 6.5 per cent sulphur dioxide. In the first half of the second wind box, or beginning at a point 12 feet beyond the ignition point, the concentration dropped very quickly so that at the center of the second wind box the sulphur dioxide concentration was only 2.6 per cent, and from that point on dropped to less than 1 per cent at the end.

TABLE 4.—*Average SO_2 content of gases coming through grates of sintering machines at various points under average operating conditions.*

Distance of sampling point from ignition point.	Proportion of SO_2 in gases with average charge.	Distance of sampling point from ignition point.	Proportion of SO_2 in gases with average charge.
	Per cent.		*Per cent.*
1 foot	1.5	12 feet	5.0
3 feet	5.0	14 feet	4.3
5 feet	7.0	16 feet	2.3
7 feet	7.5	18 feet	1.5
9 feet	6.6	20 feet	.9
10½ feet[a]		Sulphur in product	4.5

[a] End of first wind box.

SUBDIVISION OF WIND BOXES AND RECIRCULATION OF PART OF GASES.

A little study of these results suggested that if a partition were placed in the first wind box 3 feet from the ignition point, and the gases from the first 3-foot length (*h*, fig. 5) were separated from the gases from the 7-foot length (*g*, fig. 5) a concentration approaching 6.5 per cent sulphur dioxide could be obtained from section *g*.

This partition was then placed in the box, and from section *g* was obtained an average volume of approximately 2,500 cubic feet per minute at 200° C., carrying an average of 5.5 per cent sulphur dioxide. The concentration varied between 6.5 per cent under the most favorable conditions to as low as 4 per cent under very unfavorable conditions. The details of these variations are given elsewhere in a discussion of the effects of the several conditions.

It was found to be very difficult to keep the concentration of the gases in the outlet pipe up to the average of the gases coming through the grate bars, owing to leaks and to the frequent poor contact of the palettes and wind-box castings.

Having obtained a concentration of 5.5 per cent sulphur dioxide in a part of the gases, it was decided to try to increase that concentration by taking the gases from a part of the second wind box and using these gases as the air supply to section *g* of the first wind box. Thus a partition was placed in the center of the second wind box and the gases from the first half (sec. *f*, fig. 5) were drawn out by a sepa-

rate fan and conducted by suitable piping to a hood placed on section *g* of the first wind box. The hood (fig. 12) was built so as to inclose the palettes so that they would be surrounded completely with the gases and so that air free from SO_2 would be prevented from being drawn into section *g* at leaks between the palettes and the wind boxes.

Thus the space under the roasting area was divided into four sections, *h*, *g*, *f*, and *e* (fig. 5). These sections were well sealed from each other by means of horizontal strips of iron placed on the partition which made contact with the palette castings sliding over them.

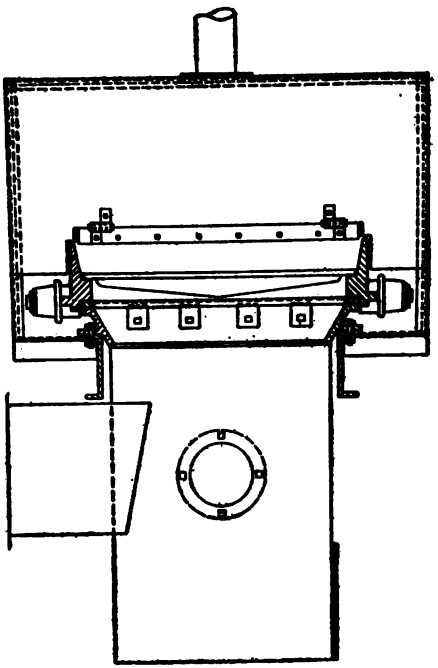


FIGURE 12.—Hood for wind box of Dwight & Lloyd sintering machine.

Under average conditions, at 160° C., the fan pulled per minute from section *f* fifteen hundred cubic feet of gas containing an average of 2.8 per cent sulphur dioxide. This did not quite supply the air necessary for the proper roasting of the material over section *g*, and some air was drawn in from outside the hood. The average volume of gas drawn from section *g* was about 2,500 cubic feet per minute at 200° C., and the concentration of sulphur dioxide varied between 6 per cent and 8.5 per cent, averaging 7.3 per cent.

EFFECT OF VARIATIONS IN CHARGES ON GAS CONCENTRATIONS.

In the two months during which these tests were made a great variety of charge conditions were encountered, not only as a result of our so planning, but as a natural result of the operating condition of the smelter. Charges varied in lead content between 24.4 and 44 per cent, but the average lead content was 34.6 per cent. Sulphur varied between 12 and 15 per cent, averaging 13.5 per cent. The variations in the physical condition of the charges were also very great from mixtures that were rather coarse to fine, dense mixtures, as shown by the following examples. The examples given show the extreme in the charges met with during the tests.

Examples of variation in constituents of charges of sintering machines.

Material.	January, 1914.			February, 1914.
	[a] 14.	[b] 22.	[c] 24.	[d] 24.
"Jigs" or coarse concentrates ..... per cent	22	24	.....	.....
Fine concentrates ..... do	23	37	70	27
Slimes ..... do	.....	.....	.....	39
Crushed quartz ..... do	10	.....	4	10
Preroasted ore ..... do	24	20	.....	14
Crushed matte ..... do	.....	.....	.....	10
Flue dust ..... do	6	.....	4	.....
Needles ore or high-grade sulphides ..... do	15	19	22	.....

[a] Coarse charge. [b] Medium coarse charge. [c] Medium fine charge. [d] Very dense charge.

Under most charge conditions, other conditions being the same, the general sulphur dioxide concentration at the several points along the hearth was rather close to the values given in Table 4.

Interesting results were obtained from a charge made up as follows:

Constituent.	Per cent.
Fine concentrates	60
Preroasted ore	18
Needles sulphide ore	6
Siliceous sulphides	13
Flue dust	3

The charge contained 34.5 per cent lead and 14 per cent sulphur. This mixture was fine, but very even. The rapid elimination of sulphur from the charge over the first wind box is shown in Table 5. With a charge of this character fairly constant gas concentrations can be maintained at the several points along the machine.

TABLE 5.—*Concentration of SO_2 at various points along the hearth with a special favorable charge.*

Distance from ignition point.	Proportion of SO_2 in gases with favorable charge.	Distance from ignition point.	Proportion of SO_2 in gases with favorable charge.
	Per cent.		*Per cent.*
1 foot	3.2	14 feet	1.0
3 feet	7.8	16 feet	.....
5 feet	11.2	18 feet	.5
7 feet	6.5	20 feet	.....
9 feet	5.2		
10½ feet [a]	.....	Sulphur in product	3.2
12 feet	2.5		

[a] End of first wind box.

The data from Tables 4 and 5 are shown diagrammatically in figure 13.

In sharp contrast to a charge of this even condition, a charge similar to that of January 8 stands out with interesting and indicative results.

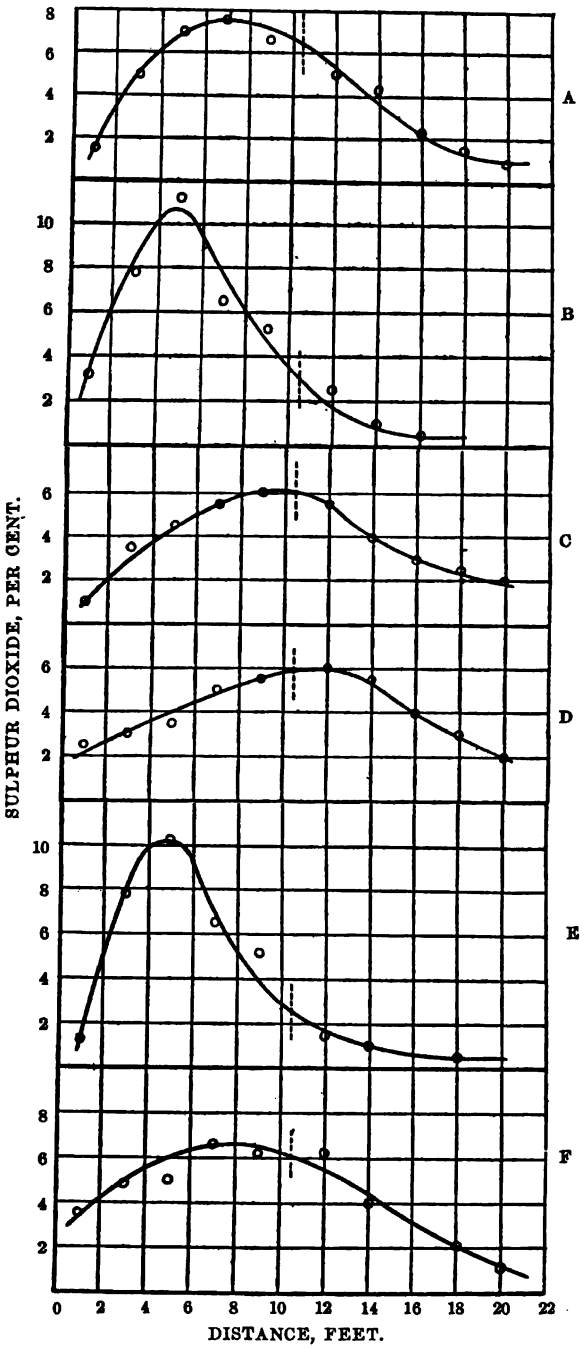


FIGURE 13.—Curves showing concentration of SO_2 in gas from sintering machine at different distances from ignition point: A, results with average operating conditions; B, results with a special charge; C, results with a coarse charge; D, results with a dense charge; E, results with good ignition and good product; F, results with poor ignition and poor product.

The charge was made up as follows:

Constituent.	Per cent.
Lead jig concentrates and slimes	35
Preroasted sulphurets	29
Flue dust	8
Needles ore	8
Crushed quartz	11
Crushed matte	9

It contained 31 per cent lead and 13.7 per cent sulphur. With this charge it was impossible to maintain even conditions in moisture content, ignition, or wind pressure, and the result was that the sulphur dioxide concentration at any point varied greatly. Furthermore, it was impossible to attain a concentration higher than 6 per cent SO_2 at any point (see Table 6). At times the SO_2 elimination would be good and the product excellent; at other times the material would hardly roast and would not sinter. The trouble was due almost entirely to poor mixing of the material in the charge. The coarser particles of the charge were separated from the finer in the feed bin and especially in the drop into the hopper over the machine. The conveying and mixing device for the machines was to a great degree inadequate to meet the conditions of a charge similar to the above. With a charge in which the material is of approximately the same physical character, the present mixing schemes are very satisfactory, and a charge of this character gives excellent results. With a dense charge, results were obtained similar to those given in Table 6. No high concentrations were attained.

TABLE 6.—*Concentration of SO_2 at various points along the hearth with two types of charge.*[a]

COARSE CHARGE.

Distance from ignition point.	Proportion of SO_2 in gases.	Distance from ignition point.	Proportion of SO_2 in gases.
	Per cent.		*Per cent.*
1 foot	1.0	14 feet	4.0
3 feet	3.5	16 feet	3.0
5 feet	4.5	18 feet	2.5
7 feet	5.5	20 feet	2.0
9 feet	6.0		
10½ feet[b]		Sulphur in product	5.9
12 feet	5.5		

DENSE CHARGE.

1 foot	2.5	14 feet	5.5
3 feet	3.0	16 feet	4.0
5 feet	3.5	18 feet	3.0
7 feet	5.0	20 feet	2.0
9 feet	5.5		
10½ feet[b]		Sulphur in product	5.4
12 feet	6.0		

[a] See curves in fig. 13, C and D.

[b] End of first wind box.

Table 7 shows the manner in which the rate of sulphur dioxide elimination can be varied by the manner of ignition. These figures were obtained from a charge of the following character:

Constituent.	Per cent.
Fine concentrates	46
Crushed quartz	8
Preroasted ore	26
Flue dust	9
Needles ore	11
Analysis.	
Silica (SiO_2)	8.5
Iron (Fe)	24.5
Lead (Pb)	33.5
Sulphur (S)	14.2

In one case the ignition was correct and in the other the ignition was too hot, causing the material to semifuse and bake on top, which prevented the air from penetrating the charge.

TABLE 7.—*Concentration of SO_2 at various points along hearth with good and with poor ignition.*[a]

GOOD IGNITION AND GOOD PRODUCT.

Distance from ignition point.	Proportion of SO_2 passing through grates.	Distance from ignition point.	Proportion of SO_2 passing through grates.
1 foot	1.3	12 feet	1.5
3 feet	7.8	14 feet	1.0
5 feet	10.2	16 feet	.....
7 feet	6.5	18 feet	.5
9 feet	5.2	20 feet	.....

POOR IGNITION AND POOR PRODUCT.

1 foot	3.5	12 feet	6.2
3 feet	4.8	14 feet	4.0
5 feet	5.0	16 feet	.....
7 feet	6.6	18 feet	2.0
9 feet	6.2	20 feet	1.0

[a] See curves in fig. 13, E and F.

It may be well to mention some of the other factors affecting the roasting process, and thus the sulphur dioxide concentration. Although it has not yet been mentioned in this report, the proportion of moisture in the charge is of prime importance, too much or too little moisture being equally fatal to good results. It is very certain that a device for the intimate mixture of the water with the charge, such as a "mixing table" as used at many smelters, would serve to eliminate some of the irregularities due to the moisture content.

It is not necessary to state that the wind pressure must be regulated to the character of the charge for a constant gas concentration,

which is another reason for desiring more perfect mixing of material, etc.

The depth of the charge on the grates is another factor influencing the gas concentration. During these tests we found that dense charges gave more satisfactory results if the depth was reduced from 4 to 3 inches, and even to 2 inches, if properly ignited. With a 4-inch layer the pressure required to draw the air through the charge caused excessive air inleakage through contact surfaces, etc.

It may be thought that undue attention has been given to the determination of the variation in the sulphur dioxide content of the gases at the several points along the machine. It was found, however, that these determinations were of great importance. By finding the conditions under which the sulphur dioxide values were like those given in Table 4 and approached the ideal conditions as shown in Table 5, not only was the concentration of the gases from section 2 higher in sulphur dioxide and contained a larger proportion of the total sulphur dioxide, but also the sintered product was greatly superior and lower in sulphur.

Provided that the ignition was adjusted to suit the conditions, there was no difficulty in maintaining a gas concentration greater than 7 per cent in the exit pipe from section 2 from charges carrying between 30 and 44 per cent lead. Of course the higher the lead sulphide content the more difficult it was to get proper ignition. The average sulphur dioxide concentrated in the gases when a charge carrying 36 per cent lead and 13 per cent sulphur was being roasted was as follows:

Charge, 100 tons per day, at 13 per cent sulphur.

Product, 90 tons per day, at 4.5 per cent sulphur.

Sulphur eliminated, 9 tons per day, or 12.5 pounds per minute.

Sulphur dioxide, 25 pounds per minute.

The average volume of gases from section 2 (*g*, fig. 5) was 2,500 cubic feet per minute, at 200° C., or 1,500 cubic feet per minute at 0° C. Thus the sulphur dioxide volume was 1,500 times 0.073, or 110 cubic feet of sulphur dioxide at 0° C., or 19.5 pounds of sulphur dioxide per minute, equivalent to 78 per cent of the total sulphur dioxide eliminated from the machine.

When the lower values, 6 per cent, were obtained, the charge was very dense, containing a large proportion of slimes, or the lead sulphide content was so high that it was impossible to get good ignition. Both conditions caused poor roasting results as well as poor gas concentration.

Throughout all the work it was clearly evident that all the conditions desired for maintaining a concentrated gas are the same conditions desired for making more perfect the roast and sinter. Thus, as the sintering conditions are improved at the plant, the conditions

for maintaining even higher gas concentration will undoubtedly be reached.

In connection with the scheme of recirculating the gases from one part of the machine through another, not only do we decrease the total volume of air used and thus increase the resulting gas concentration, but we are also able to filter out the fume present in the first volume. While rehandling the No. 3 (*f*, fig. 5) gases through No. 2 (*g*, fig. 5) the surface of the charge, after leaving the hood, was coated with white fume filtered from the No. 3 gas.

PROPOSED SCHEME FOR OBTAINING A GAS OF HIGH SULPHUR DIOXIDE CONTENT FROM A BATTERY OF MACHINES.

From the fact that we were able to get a concentration of 7.3 per cent sulphur dioxide by recirculating No. 3 [a] gases through No. 2, we are justified in stating that by taking all or a part of the gases from No. 4 and circulating these through No. 3 and the resulting gas from No. 3 through through No. 2, the concentration can be raised to at least 8 per cent, and in so doing we will have over 85 per cent of the total sulphur dioxide in a volume of 1,500 cubic feet (0° C. and 760 mm.).

To do this would require three small fans per machine, or the same result could be accomplished in the battery of three machines as follows, namely, one large fan could be placed to draw the gases from the No. 4 sections of all the machines, which would be discharged into a header pipe, from which other pipes would conduct the gases into hoods placed on the No. 3 sections. Another fan would draw the gases through the charges on No. 3 and discharge into header pipes over No. 2. A third fan would draw the gases through the No. 2 sections and discharge into the apparatus placed for the treatment of the gas. A fourth small fan would be required to draw out the gases from the No. 1 sections, and discharge them into a flue, as these gases are very dilute and contain practically all the water that was present in the charge. As there is now one fan for each machine, this scheme could be installed with the purchase of only one fan.

The chief objection to a scheme such as the above is that the shutting down of a fan for repairs, etc., might mean the stopping of the whole battery of machines. This objection could be overcome by suitable dampers in partitions and by-passes between the header pipes.

Another objection to this scheme is that the same number of fans would be required while only one machine was being operated as

[a] For an explanation of the numbers referred to in this section, see page 67.

when three were in operation. However, the greater part of the time there will be two or three machines operating, unless the smelting practices of the plant change.

One desirable feature of this scheme is that in the circulation of the gases through the charge the fume and dust is filtered out, so that the only dust and fume that will require removal from the final gas volume will be that drawn through No. 2 section, which is very small.

SUMMARY.

Summarizing the results of the investigation briefly, it may be stated that under the charge and operating conditions consistent with good roasting and sintering results, we have obtained at least 75 per cent of the total SO_2 from the machines in a gas volume that had an average concentration of 7.3 per cent SO_2.

We have divided the roasting area of a machine into four sections, which, beginning at the ignition part, we have designated as follows:

Section.	Length in feet.
1	3
2	7
3	5
4	5

From section 2 alone we have drawn out a volume of gas containing 5.5 per cent, or 55 per cent of the total SO_2 produced in the machine. From section 3, we have obtained a gas containing 2.8 per cent SO_2. By conducting the gas from section 3 into a hood placed over section 2, we have raised the concentration of the gases in the exit pipe from section 2 to an average content of 7.3 per cent of SO_2. This gas then contained 78 per cent of the total SO_2 eliminated by the machine.

In order to gain these results, we have found it necessary to maintain certain conditions, the most essential of which are as follows:

1. The variations in the physical condition of the charges should be kept within limits that will exclude very coarse lead concentrates, coarse raw matte, and lumpy materials. This limitation would also exclude the presence of an excessive proportion of lead slimes in the charges.
2. The constituents of the charges should be intimately mixed.
3. The charges should contain the correct moisture content, which should also be intimately mixed with the other materials.
4. The ignition of the charges should be carefully watched.

All of these conditions are equally as essential for the best roasting and sintering results for the production of a gas of high concentration, and the attainment of these conditions is well within the range of smelter operating practices.

The chemical composition of the charges may vary within the wide limits that will still allow of a successful roast and sinter, and, if the conditions above mentioned exist, the high gas concentration can be realized.

Furthermore, we have concluded that should it be desirable, 85 per cent of the total SO_2 can be concentrated in a volume that will contain a concentration of at least 8 per cent of SO_2. This, however, would call for a rather more complicated arrangement of fans and air-pipe lines, but would still be practical.

With a concentration of 7 to 8 per cent it is possible to apply a commercial scheme for the recovery of sulphur dioxide, either as liquid sulphur dioxide, sulphuric acid, or sulphur.

A DETAILED STUDY OF STATEMENTS OF RESIDENTS OF THE SELBY SMOKE ZONE AS REGARDS THE PRESENCE OF A NUISANCE IN THE AREA.

By C. B. Dutton.

STATEMENT OF SUBMITTAL.

I submit herewith the following report of the results of my investigation in and around the city of Benicia, Cal., with respect to conditions reputed to result from the operation of the lead smelter and refinery located at Selby, Contra Costa County, and owned by the Selby Smelting & Lead Co., of San Francisco.

INTRODUCTION.

The investigation was made with the idea of developing, so far as possible, evidence along the lines of the findings required to be made by the stipulation appointing the commission. Under the terms of this stipulation the commission is to report to the parties "concerning the operation of the defendant's plant with respect to emission of deleterious or injurious smoke, fumes, and gases, if any, therefrom, and the effect, if any, thereof upon the territory alleged to be affected," and to find (*a*) whether the defendant's contention is true that it is not operating its plant "in a manner to violate the decree heretofore duly given," or (*b*) whether the defendant is "operating its plant in such manner as to produce smoke, fumes, and gases offensive to the senses, or destructive to the property of people residing in said district of Solano County, or so in any manner to be violative of the said injunction."

The material questions, then, were whether or not the Selby plant still constituted a public nuisance within the meaning of that finding and decree, and to what extent, if any, the operation of such plant interfered with the comfortable enjoyment of life and property, injured animals and vegetation, or depreciated the price of crops.

SCOPE OF INVESTIGATION.

The investigation covered all of the outlying ranches or farms within the smoke zone, so called, and a considerable part of the city of Benicia. Effort was made to see all the ranchers, but with incom-

plete success, as several of them could not be found at home, despite repeated trips to the premises. The great majority of the ranchers, however, were interviewed.

Before taking up the work, I proceeded to Vallejo and had several conferences with Mr. H. J. Widenmann, one of the board of county supervisors, with Mr. Joseph M. Raines, the district attorney of Solano County, and with Mr. J. R. Glendon, another member of the board of supervisors, at Benicia. I discussed with them the manner in which it was proposed to cover the ground, and found that the plan met with their approval. It seemed best to all of us to cover the outlying ranches before taking up the work in Benicia, and this was accordingly done.

At the outset it was realized to be hardly possible to make a house-to-house canvass of the entire city of Benicia. The most practicable plan seemed to be to make a canvass of the business men of the town, and also a house-to-house canvass along the water front, where the smoke was alleged to be the worst. Supplementing this, it seemed desirable to have a selected list of representative citizens, whose views could be considered as fairly expressing the sentiment of the community. This plan of procedure met with the approval of Mr. Gould and Dr. Franklin of the commission, and of Supervisors Glendon and Widenmann, District Attorney Raines, and of Mr. Crooks, the president of the board of trustees of Benicia. Mr. Crooks undertook to give me a list of the business men of the city, and requested Mr. Johnston, who is a member of the anti-Selby fumes organization, to give me a list of representative citizens. Mr. Glendon also agreed to give me a list of some 40 or 50 names. Some 200 names, counting duplications, were thus furnished to me. I interviewed some 150 persons, most of them being named on these lists. I did not stick too close to these lists for obvious reasons, but found them to have been fairly selected and to include the really representative citizens of the city. So far as the main part of the city of Benicia is concerned, the testimony seemed so uniform and consistent that it hardly seemed necessary to prosecute the inquiry further. Accordingly, with the approval of Mr. Gould, the taking of further testimony was stayed until the results of these interviews could be compiled.

The situation with respect to nuisance or damage resulting from the smelter operations seems to separate conveniently into two divisions, and is so treated herein, the one relating to conditions on the ranches outside of Benicia, and the other relating to conditions in the city proper, although the questions at issue are one and the same.

INTERVIEWS WITH RANCHERS.

Some 34 ranchers, or their wives, were interviewed, comprising the majority of those engaged in ranching in the affected district.

SMELTER SMOKE, DUST, FUME, AND GASES.

With respect to the smelter smoke, I found it impossible to get any definite idea as to the frequency with which the smoke has come either during this present year (1913) or during 1912. The best that could be done was to get some general statement from which inferences could be drawn.

CONDITIONS DURING 1913.

With two exceptions, all conceded that there has been an improvement this year; in most cases a considerable improvement. One exception was a farm hand (witness No. 7) who has lived in the district for two and one-half years, and whose testimony was contradicted by that of his employer (witness No. 6). The other exception was witness No. 11, who claims that conditions are just as bad as ever. The great majority declared that conditions were nothing like they have been, "not near as bad," "not near as frequent," "much better," "nothing like as bad," etc., being some of the typical expressions of opinion. Only one person claims not to have noticed the smoke at all this year. While the others claim to have noticed it to some extent, it has only been occasionally. Witness No. 16, for example, has been unable to get a "strong whiff of the smoke" during the entire year, though he has been constantly on watch, so as to be able to file a complaint of violation of the injunction against the smelter. The majority seem to feel that existing conditions are satisfactory; that is, do not afford ground for serious complaint. Witnesses Nos. 4 and 11 are the only ones who complain that the smelter smoke is still a nuisance. Such smoke can not be much of a nuisance to the former witness when he has rented this same ranch for 18 years, and when he has given the smelter company a smoke easement over it. Witness No. 4 was influenced by hope of getting the smelter company to purchase his lands in making a statement of this sort, as a perusal of the testimony will show, and even this witness concedes that the smoke is "not so bad" this year.

Only 4 persons out of 34 claim that the smoke when noticed is as strong or as disagreeable as it was three or four years ago. These are witnesses Nos. 8, 18, 22, and 11. Witnesses 11 and 15 are the only ones who claim to have had the smoke during the present year with any degree of frequency. The others make no assertion of having had it more than a few times this year, though just how many

that means it is impossible to state. All efforts to get definite figures were futile. It can not have been very many, or conditions would unquestionably have been declared to be bad, judging from the comments repeatedly made in my presence.

CONCLUSIONS AS TO CONDITIONS IN 1913.

Although the lack of data as to the exact number of times the smoke has been observed is to be regretted, yet it is impossible to conclude from the testimony as a whole, and the manner in which it was given, that the smelter has constituted a public nuisance during the present year with respect to the emission of sulphurous gases, noxious fumes, or smoke.

I found no evidence of injury to health at the present time due to smelter operations. The daughter of witness No. 15 claims that the smoke injured her health in the past. Several women spoke of being made sick when the smoke used to come, but that does not appear to have occurred during the present year.

I am convinced that it can not reasonably be found from the testimony, as a whole, that the smoke, gases, or fumes emitted have been so offensive to the senses as to interfere with the comfortable enjoyment of life and property during the present year. The testimony does tend to establish such a condition three to seven years ago.

CONDITIONS DURING 1912.

As regards the year 1912, the testimony is not so unanimous. Five of these 34 persons claim that conditions were bad in 1912, "about as bad as they ever had been," while 5 more state that the year was an improvement over preceding years, but still was "not as good as the present year." The remaining 24 link the present year with last year and claim that the smoke has not been as bad for the last couple of years, some specifying two years and others three years, although the majority say the former. Only one person out of this number claims not to have observed the smoke at all, either during 1912 or 1913, while one other claims not to have observed it during 1912, but to have noticed it a few times in the month of August of this year. With these two exceptions, all of these 34 persons claim to have noticed the smoke at some time or times during both years. The same inability to give any idea as to the frequency of the smoke was found to exist.

The only conclusion to be drawn is that the great majority of those living on the ranches did not find the smoke during 1912 to be a matter of public nuisance or such as to interfere with the comfortable enjoyment of life and property. This for the reason that the great weight of the testimony is the same for the two years. Five persons

instead of two persons claim to have found conditions as bad as ever, while five more found them worse than during this year. These 10 persons do not live in any one section of the zone affected by smelter smoke, but are scattered throughout the region. Witness No. 18, for example, claims that the smoke came just as often and was just as strong during 1912 as ever, while his neighbor, across the road (witness No. 19), says that in the last three or four years she has been bothered very little, and has not "smelled any smelter odor for a long time." Witness No. 16, whose ranch adjoins that of witness No. 18, stated that 1912 was an improvement and was "not half as bad" as before. Witness No. 8 claims that the smoke was as frequent as ever last year, but witness No. 5 on the next farm found it "better than before." Weighing all the evidence and taking into account conflicts such as this, it is not believed that the evidence establishes the existence of a nuisance during 1912 any more than during 1913.

DISCUSSION.

While a comparative mode of expression is unsatisfactory, it seems to me that a fair interpretation of the evidence, taking everything into consideration, is that when the statement is made that conditions are "not as bad," "are nothing like as bad," etc., it is practically equivalent to saying they are not bad. This would not be a safe conclusion generally, but I believe it to be in this particular instance. If conditions had been found bad, there would be no hesitation in saying as much. If the smoke came with considerable frequency and constituted a serious annoyance, a positive nuisance, it would seem that some very definite idea would exist as to the extent of the nuisance; that there would be some distinct recollection on the subject. This interpretation does not mean that the smoke has not been observed at all, but does mean that it has not been observed to that extent and degree which would justify a finding that it constituted a public nuisance.

I tried repeatedly to get some statement as to the number of times per week or month that the smoke had been observed either during 1913 or 1912, but without success, the answer usually being that it all depended upon the wind; the smoke might come for two or three days at a time, and then not come again for a couple of weeks, for example, so that they could not tell definitely. When I found they were honestly unable to give any idea, I refrained from making suggestions as to the number of times, which would call forth a purely perfunctory assent, and not give a true index to conditions.

There is a feeling that exists generally, both in the outlying district and in Benicia itself, which must be taken into consideration in passing upon this evidence. There is a good deal of skepticism as to whether any improvement has been effected, particularly with respect to

injury to stock, in spite of the fact that the smoke is not observed as often. This manifests itself, for one thing, in the unwillingness of a number of farmers to leave horses out over night, and for another, in the belief that the winds are carrying the smoke in a different direction. This feeling is that after years of fighting they have obtained a "hardly won" advantage over the smelter, and it is necessary for them to retain it for their own comfort and security. It is felt that if the smelter is found not to be a nuisance by the commission, then the plant, being relieved of the burden of the injunction, will resume operations on the old scale, and conditions will soon be as bad as ever. This feeling is quite prevalent, and is openly expressed by many. It is important to keep the existence of such a feeling in mind in considering the transcript of the evidence, as it undoubtedly manifests itself to some extent in the hesitating and equivocal forms of expression employed to describe existing and past conditions.

As a result of this feeling, a considerable prejudice was found to exist toward the commission, both in Benicia and the district outside, the sentiment being that the commission was appointed to "whitewash" the smelter. It was necessary to counteract this impression, and to devote some time to a friendly chat explaining the purpose of the commission, the manner in which it was at work, and emphasizing the fact that this commission was equally the representative of each party to the controversy. So general was this prejudice that it was soon found advisable to make some such explanation in advance before attempting to question. The fact that Federal employees were connected with the investigation seemed to assist to some extent in gaining the confidence of the persons interviewed, and in counteracting this initial prejudice.

There is the same variety of opinions with respect to conditions that would be found upon almost any subject. But considering the weight of the evidence for these two years, and taking into consideration the existence of such a feeling as that referred to, and the relative credibility of the witnesses, as it impressed itself upon me, I believe the conclusions above expressed are fair and reasonable.

SMELTER SMOKE AND OIL FUMES.

The Selby Company has been claiming that the more offensive odors complained of in the past were attributable to the oil works located just below the plant, at a place called Oleum. While the testimony is not sufficiently detailed, and could not be so obtained, to permit of definite conclusions, yet it does tend to confirm this claim to some extent. The stills at this oil works were capped in July, 1910, but some trouble was experienced with them up to July, 1911, or thereabouts. It is claimed that it was the custom to empty these stills

sometime during the night or early morning and that the odors complained of are the highly penetrating gases given off in the distillation of crude oil for asphalt manufacture. The smelter, in the meantime, has been operating on the same scale, and has been turning out increasing and not decreasing quantities of sulphur. Keeping these facts in mind, the following condition appears suggestive, at least.

The majority of ranchers find that conditions have been much improved in the last two or three years. A little more than two-thirds are of this opinion. More than half of those who testified concerning the time when the smoke came noticed it worst during the night or early morning hours. Eleven identify the smell as similar to that of sulphur, while 12 claim it as something else, most of them calling it "a nasty smell," "a suffocating odor," "an awful smell," "resembling a dead cat," "rotten-egg smell," etc., while five can not identify it. It seemed to me that some of those who called it a sulphur smell did so because it was suggested to them by me, after they had failed to give any opinion at all, and others because the common talk has been of sulphur fumes. For instance, witness No. 19 first said that the offensive odor was like "a dead cat," and in the next breath stated that it was like burning sulphur. In nine cases the fumes "used to bring on nausea or sickness," and in four others "produced a choking, suffocating feeling."

While it is true that the smelter smoke alone would probably be most offensive in the early morning, owing to the air being heavier and preventing the smoke from being diffused as rapidly as at other times, yet it seems difficult to believe that sulphur dioxide could have been present up to two or three years ago to the extent complained of without causing a great deal of damage. Yet no such damage is established. The smelter has continued to operate since on practically the same scale without a like degree of complaint, so that, while the testimony does not throw as much light on the question as could be wished, and this because the witnesses were not close enough observers, and also because they would not submit to the grilling examination or questioning necessary to follow up all these different leads, it does seem to suggest that something was present in the atmosphere up to about two or three years ago that had a different odor and effect from the characteristic smelter smoke. The effects attributed to this condition which prevailed at that time seem quite different from those commonly attributed to sulphur gases or sulphuric-acid fumes, and differ as much therefrom as the description of the odor differs from what would be expected as a description of sulphur gases or sulphuric-acid fumes.

A detail noted in this connection is that practically all of those testifying complain of irritation of the mucus surfaces of the throat, resulting in a cough or "hack." This is a condition that might and would

probably result from the presence of sulphur-dioxide gas in appreciable quantity. Whether allyl sulphide or any ethylene hydrocarbons alleged to be found in air affected by oil-refinery gases produced the more offensive odors then complained of is something for the chemists to determine. It can be said at least that there is sufficient in the testimony to justify some effort to determine this as a fact, if the condition still existed.

The capping of the stills has not eliminated all complaint, however, as witnessed by the fact that only one person claims not to note the smoke at all, and indicates that the oil fumes were not the whole nuisance complained of. It is possible that these oil fumes still continue to come. Little or no evidence confirmatory of this was obtained. Eight out of 34 persons claimed to have recognized "oil odors." Six of these could not identify the odor, while the others described it as "a crude-oil smell" and as "resembling the odor at the oleum plant," respectively. No idea could be obtained of the number of times these fumes were observed. It appeared to be the consensus of opinion that they were noticed much less frequently than the smelter smoke, though still observed to a limited extent. These oil odors were not claimed to be offensive, and I was impressed that some of the claims of ability to detect oil smells were due merely to the fact that such smells were claimed to exist, that is, to the disinclination of some to admit ignorance of something on which others claim to be informed.

The smoke is not alleged to hang about for a day or for hours now, as it did formerly, which would make it appear that with the elimination of the oil fumes the sulphurous acid gas is not as annoying to the majority of people, assuming that the irritation and hacking cough before were due to smelter smoke. This tends to the conclusion that the more offensive odor then observed constituted a considerable part of the nuisance alleged. Even though the sulphurous acid gas is noticed at varying times, it seems to be so diffused and come in such small bodies that it is not the subject of bitter complaint, as was the smoke of a few years back, save in a few instances. These instances may be accounted for by the fact that some people seem to be more sensitive to it than others, on account of throat weakness, etc.

INJURY TO ANIMALS.

With the exception of witness No. 1, none of the ranchers interviewed claimed to have lost any stock from the smelter during the present year. This witness did not make a positive claim that the death of his three cows was attributable to the smelter, but made a statement intimating as much, in such a way as to indicate that he did not know what their death was due to. I have recently been informed by witness No. 12 that one of the three colts which he

claimed to have been "smelted" three years ago died within the past two weeks. As he has two other colts in the same condition, it should be possible to learn something of the cause if an examination is made by a competent veterinarian. With six exceptions, no one claims to have had any trouble with horses since the blast-furnace bag house was constructed and placed in operation.

DAMAGE TO HORSES.

Witness No. 8 claims to have had a colt "smelted" about three years ago; witness No. 12 claims to have had three colts "smelted" three years ago; and witness No. 9 claims to have had three colts "smelted" about four years ago. Witness No. 1 claims to have lost three horses in 1910, and witness No. 24 two horses about four years ago. This constitutes the extent of the damage to horses that is claimed by the ranchers interviewed in the past five years.

It is only fair to state that numbers of the farmers still refuse to leave their horses out at night for fear of further damage from lead poisoning. In the last year or two a few of the farmers have been leaving them out more. Witness No. 13 has been placing colts out for three years on the tule just across from the ranch of witness No. 11, stating he "did it for a test," but has noticed nothing wrong. The latter has had his colts out this year and has not observed anything out of the way. Witness No. 18 has put his horses out this year with no ill effects. Witness No. 20 placed two colts out last year and one out this year with no ill effects. Witness No. 12 has been leaving his colts and horses out, and states that the horses "smelted" six or seven years ago are not getting worse, and up to the time of the death of the one colt the colts continued about the same.

It is impossible to prove or disprove what these witnesses claim about the colts and horses lost in prior years, so that their statements must be weighed in the light of the facts developed. Witness No. 5 told me he was satisfied that no damage to stock had been done since the bag house was installed, as he would have heard of it if there had been any. He had not learned of his neighbor (witness No. 8) having suffered any losses subsequent to that time. The fact that several of these witnesses had suffered horse damages, which the smelter had paid for, lends weight to their claims.

It is perhaps as appropriate to state here as any place that the smelting company in past years has settled for horses on the claim of the owners without making any thorough investigation. This came to me from a number of widely different sources, and I am convinced it is true. I was told of instances where horses died from natural causes, and yet the company made a liberal settlement for their alleged poisoning. Again, the purchase of lands by the smelter, which is taken to be an admission of continuing injury to such lands

and the payment of damages for the death of horses naturally awakens a disgruntled feeling on the part of those who consider that they are similarly situated but did not receive like liberal treatment.

DAMAGE TO COWS AND OTHER ANIMALS.

Witness No. 1 claims to have lost 50 cows in the four-year period from 1909 to 1913, the greatest losses occurring in 1910 and 1911. He lost some cows in 1912, and three cows of his herd died this year after the sale of such herd to his lessee. These cows had a cough, suffered loss of appetite, and got poorer and poorer until they died. He did not have any of the cows examined by a veterinarian. The Selby Co., however, claims to have bought one of these cows and to have had an autopsy made, with the result that traces of tuberculosis were found. They claim to have obtained an affidavit from the witness to the effect that the other cows which had died were similarly affected, and further claim that since this autopsy he has not said very much to them about smelter injury to his herd.

The smelting company further claimed that the milk from the ranch of this witness had been barred from the city on account of tuberculosis. Inquiry at the office of the board of health failed to confirm this statement. It was learned, however, that the herd had been examined by the milk commission of the county medical association and a certificate given. The milk as a result came to San Francisco as certified milk and was examined by the board of health officers. It was found that the bacteria content of the milk was increasing, and as the witness failed to comply with some of the requirements of the board, the certificate was taken away and the milk no longer examined. The milk still enters the city as market milk but not as certified milk. During the period that examination was made of the milk no traces of tuberculosis were found. This does not mean that tuberculosis was not present in the herd, as I was also informed that the milk from a tubercular cow is not necessarily tuberculous. The description of the condition of these cows prior to their death would seem to suggest tuberculosis.

Witness No. 24 claims to have had trouble with his dairy herd in 1910 and 1911, but to have had none in the last two years. In the two years mentioned he lost about 14 cows. These cows began to get thin and poor and fell away until they died. He asserts it was not tuberculosis, as the cows did nor fall away enough for that, and went down too rapidly. The cows "coughed and got poor." The condition described would seem to indicate tuberculosis, and, as a partial confirmation of this, witness No. 44, a butcher in Benicia, stated in the course of my interview with him that some three years ago he bought some cows from witness No. 24 and found the cows to be tubercular. He told the latter of this finding and declined to buy

any more cows from him, although one of the sons has been in several times since trying to sell some. Witness No. 44 also asserted that within five years there has been a considerable amount of tuberculosis among cattle in and around Benicia. None of these cows was examined by a veterinarian.

Witness No. 20 claims to have lost a number of cows prior to 1908 and to have lost one cow in each of the years 1911 and 1912. These cows dried up and seemed to do so poorly that he killed them. He opened one of them and found "the throat filled with a black substance as far as the brisket." This he seemed to think was a "lead" or or other deposit from the smelter. Witness No. 25 also claims the loss of four cows four or five years ago (the date not being fixed), along about the time they put in the bag house. These cows coughed but remained fat. None was examined by a veterinarian.

Witnesses Nos. 16 and 18 both claim to have had trouble with sheep during the past five or six years. The latter still has a few sheep, but the former sold his flock a year ago. The first witness claims to have suffered $4,000 loss in two years' time, namely, 1911 and 1912. Neither had the sheep examined by a veterinarian, although witness No. 26 declares he "opened one or two of the sheep and found the lungs filled with a black substance just like the horses that had died years before." These sheep, according to this same witness, were all short-winded and would "hang behind the flock when run by a dog, falling down if urged for any distance." The other witness referred to asserts that the sheep did "poorly," became "thin and poor," and were "dying off all the time." His claim was that he never found the dead sheep in time to have an examination made. The fact that the sheep did not multiply in anything like the proportion they should theoretically was cited by both as an indication of smelter damage.

CONCLUSION AS TO DAMAGE TO STOCK.

At the time of the trial of the injunction suit the damage to horses was one of the chief points made against the smelter. This damage extended throughout the so-called smoke zone, and was both general and continuous. Sheep and cows were declared by most witnesses to be immune, although two witness claimed at the trial to have had cows "smelted," losing three cows altogether. Witness No. 12 claims now to have lost a number of cows years ago, which he believes were "smelted," but this fact was not developed at the trial, which seems a little strange. Witness No. 11 claims to have lost a number of sheep in 1906, but not earlier, and makes no mention of any loss since.

It is rather a peculiar circumstance, then, that there should be more claim of damage to cows and sheep since the bag house was put in operation than there was before. It would not seem that any of the

cow losses suffered in the past five years can be attributed to the Selby smelter. The description of the symptoms in most instances suggests tuberculosis, and the fact that tuberculosis was prevalent in the region tends to strengthen this conclusion.

The claims of witnesses Nos. 16 and 18 regarding sheep losses are not convincing as to smelter damage.

Summing up the evidence on the question of destruction or injury to stock, the great weight of evidence is to the effect that no damage has been done to stock (not including horses) since the bag house was installed. The death of the three cows belonging to witness No. 1 is the only claim of injury during the present year. This claim is not convincing in the light of all the testimony, since it is difficult to see why his place should be injuriously affected while other places in the same neighborhood and similarly exposed were immune. The only conclusion that can be reached from the statements of the farmers is that the smelter is not emitting at the present time any fumes that are a cause of injury or death to stock.

The losses of cows suffered by witnesses Nos. 1 and 20 and the sheep losses of witnesses Nos. 16 and 18 are the only claims of injury to stock last year. This evidence is not convincing as to damage or injury during 1912, and it is not believed such evidence of isolated damage can justify a finding of violation of the injunction in this respect during that year.

There does not appear to be any evidence sufficient to warrant the conclusion that the smelter has been a cause of damage to stock since the blast-furnace bag house was installed.

With reference to the damage to horses, it is more difficult to reach a conclusion. The fact that the smelting company has admitted doing such damage in the past and has made monetary settlements therefor complicates the matter, since witnesses Nos. 8, 9, and 12 all received money from the smelter for horse losses and, therefore, their claim that these horses were affected similarly to those whose deaths were paid for carries weight. The fact is that no claim of injury or damage to horses within the past two years is made in these statements, but it is made in two instances as regards 1910, and in two instances as regards 1909.

INJURY TO VINEYARDS AND ORCHARDS.

In the course of this investigation it was not possible to find or learn of any case of typical sulphur dioxide damage to vegetation. I examined superficially a number of orchards and vineyards, but could find nothing resembling typical smelter burn. There is a great deal of claim and talk of damage to orchards and lands, but inquiry fails to sustain any such claim. Not a single person interviewed

claims to have noted the alleged damage at any particular period of time. The damage is claimed to be invisible and cumulative, and to be observable only after a period of months or even years. The smoke has never been known, so far as I was able to ascertain, to come down at any one time and to have burned any orchard or tree. This fact in itself should be reasonably conclusive on the question of alleged smelter damage to trees and orchards. It is so opposed to the characteristic damage from sulphur smoke elsewhere that it is impossible to believe that the injury complained of is due to the operation of the Selby plant. It might be possible to have cumulative damage if the sulphurous acid gas were constantly present for a greater or lesser period of time, or else be present at frequent intervals over a longer period in small quantities until the resistance of plant or tree to such influence was overcome. If this were the case, one would naturally expect to find a general complaint of greater injury to one class of trees than others, since the resistance powers of all would not be equal, but nothing of the sort is found. Furthermore, such a supposition premises that the smoke would be constantly present, in which case there would undoubtedly be complaint of continuing annoyance, which is contrary to the facts. There is one thing further against such a supposition, and that is so far as known no case of invisible economic damage from sulphurous acid gas has ever been established.

One thing stands out prominently in this claim of smelter damage to orchards, and that is the number who claim damage in 1910 but not since. Witnesses Nos. 5, 8, 11, 12, 26, 27, and 28 all claim to have had fruit trees or orchards injured in that year. As indicating the general nature of this condition, it may be stated that of those living in Benicia witnesses Nos. 45, 46, and 47 claim to have had orchard growth "killed" at that time. From the statements of the witnesses it would seem more like a blight of some sort than a smelter burn. Witness No. 48 also had trouble in that year, while witness No. 49 "had some splendid shade trees injured"; "the trees seemed to die out, the leaves wither and drop, and the shoots dry out;" "the damage was observable on the westerly side and top of the tree first, and the trees just seemed to die out gradually." No similar damage was observed before or since. As far as could be learned, this damage was not done at any one time, but was a matter of progressive development and was a general condition which manifested itself during that year. It seems rather peculiar if it were smelter damage that it should have occurred only during that year and not before or since, particularly when the volume of sulphurous acid gas has not been lessened. It would be expected to find the condition recurrent over a period of years if due to smelter operations. Witnesses

8, 11, 12, 27, 28, and 48 all say that their orchards are doing all right since. Witness No. 27 does not claim the loss of his orchard was due to the smelter.

The following are the particular cases of present damage alleged:

Witness No. 1 has a small orchard by the house, that he claims is being killed by the smelter. It has been set out for several years, but is not bearing fruit and looks poorly. He also has an eucalyptus grove that he believes the smelter is affecting. One side of this grove had been burned by a grass fire, but the trees looked as well as could be expected considering the drought. No evidence of sulphur dioxide burn was observed. It is interesting to note that witness No. 25, only a few rods farther up the road, claims no damage to trees or vineyard, the smoke not troubling those residing on the other side of the road.

Witness No. 5 has an almond orchard of five years' growth that he believes is slowly being killed by the smelter. This orchard sets on an exposed hillside, where it gets the full sweep of the cool winds and salt air from the bay. No particular damage is alleged save that the trees are doing poorly, in spite of what he considers careful cultivation. He also has a row of cypress trees by the house, set out about 40 years ago, that have commenced to die within the last year or two, a condition that he attributes to the smelter.

Witnesses Nos. 4 and 14 both claim that their orchards have been killed by the smelter, the trees dying after several years. Both orchards appear neglected.

Witnesses Nos. 16, 18, 20, 22, 24, and 26 all believe the smelter is injuriously affecting fruit trees and vines. Witness No. 16 claims, as proof of smelter damage, that trees set out four or five years ago do not have any greater growth than trees two or three years old. Witness No. 22 claims that foliage is less and that fruit does not mature, does not "develop the way it should," and the "way it does elsewhere." Witness No. 18 claims that each year up to this year after the vines had blossomed something in the air seemed to affect them so that the grapes did not form. Both witnesses Nos. 16 and 18 claim that this is the best year for fruit they have had for a long time in spite of the lack of rain. The latter also claims the smelter smoke has interfered with vine graftings, causing the loss of $1,000 worth of graftings which did not take owing to the smoke. Witness No. 24 has a vineyard about 10 years old that has died because of the smoke, and an orchard that is being killed. He states the trees begin to die out on the side toward the smelter and on the top, while the other side remains green. They do this year after year for a few years until the orchard is ruined. He pointed to the sparse foliage at the top of the trees as evidence of smelter damage.

Witnesses Nos. 8, 11, 12, 27, 28, and 49 all make no complaint of present conditions; in fact, all say their orchards, vines, or trees are doing all right now.

The question of smut on the trees, of which a number of these persons complain, will be taken up separately. From this brief résumé it will be observed that the complaints of damage all relate to general conditions, the growth of the trees, the development of the fruit, or the dying of the trees extending over a period of months and even years.

CONCLUSION AS TO INJURY TO TREES.

There is absolutely no evidence indicating that the smelter smoke has had an injurious effect upon orchards and trees on these ranches during the present year. There is no evidence indicating that it has injuriously affected trees at any time in the past. None of the injury complained of seems typical.

INJURY TO CROPS AND LANDS.

No instance of characteristic sulphur dioxide damage to crops of any kind was either observed or learned of. No person claims that any crop was at any time burned by the smoke from the smelter. The only claim in that respect is that lands exposed to the winds from the smelter do not raise as good crops as lands not similarly exposed. In this connection it is claimed in several instances that lands on the same ranch not exposed to the fumes produce an average crop while lands that are exposed yield only half as much. The feeling is that the land has been "poisoned" by the lead emanations, so that it can not produce as it should. This feeling is the outgrowth of the damage to horses that occurred in the past, the reasoning being that if the smelter was responsible for the deposits of lead and arsenic that brought about the death of the horses, then such deposits accumulating over a period of years would be equally injurious to all plant life and growth. A number of the farmers mentioned this "poisoning" of the land, but, strange to say, it was mentioned to me more frequently in Benicia than by the farmers themselves.

While this claim is unreasonable on its face, still the prevalence of the opinion requires that it be given consideration. The remark is frequently made in Benicia that years ago the country around Benicia used to produce the finest fruits and the largest grain crops that were grown in the State, but that since the smelter started running, the lands no longer produced as they should. This condition is attributed entirely to the smelter, ignoring the fact that the lands have been farmed continuously for a great many years without, in many instances, the use of fertilizers and without deep plowing, and that a light top soil is found throughout the region with a "hard pan" underneath, making retention of moisture difficult.

Witnesses Nos. 4, 9, 12, 16, 17, 18, 20, and 24 claim this condition exists, although witness No. 12 mentioned it only casually, while the others make a point of it. On the other hand, witnesses Nos. 1, 5, 8, 11, 19, 21, 25, 27, 28, and 29 make no mention of any such effect. Witness No. 10, who lives just below witness No. 9, declares that given water he can raise any kind of a crop without difficulty, and witness No. 21, who lives out by witness No. 16, makes the same declaration. It seems peculiar that some lands should be affected and not others, when the lands are similarly exposed.

OCCURRENCE OF SMUT.

There is one condition that has formed a subject of general complaint, and that is the presence of a black soot or smut, which spreads over the fields, blackening crops and stubble and also blackening fruit trees and fruit. Because of the fact that it was so noticeable, the presence of this substance has led to many of the claims of damage to orchards and lands.

The same thing that was remarked upon in connection with the discussion as to the relative amount of nuisance created by smelter smoke and oil fumes, namely, the improvement which seems to have been noted subsequent to the capping of the oil stills, is noticeable with respect to this smut. This smut, according to the testimony, was worse in the period prior to 1910 than it has been since. There seems to be no difference of opinion upon that point. It is not as noticeable either in the fields or on the trees, although it is still present to some extent. Witnesses Nos. 5, 8, 16, 18, 20, 22, 24, 26, and 28 all claimed to have noticed it this year, although to a much less degree. Witness No. 16 declared the smut was not 25 per cent of what it used to be, while the others declared it was "quite a little" less in the last couple of years. Witnesses Nos. 1, 9, 10, 11, 19, 21, 25, and 27 make no mention of it whatsoever, while witnesses Nos. 12, 13, and 30 claimed not to have observed any this year.

This smut, as near as I could get the various persons interviewed to describe it, seems to be slightly greasy in character; that is, it is not a dry, powdery substance, but something more sticky that clings to whatever it alights upon and does not brush or rub off. It was not a mold and did not seem to be an earth dust. Evidence of this smut was found on the ranches of witnesses Nos. 16 and 24, where it was particularly looked for. This smut is believed to be a lead deposit by witnesses Nos. 12, 16, 22, 24, and others. This belief on the part of witness No. 16 is based on the fact that a leaf bearing this deposit makes a "black mark resembling that made by a lead pencil." Witness No. 22 says it is sort of "grayish, like lead." I was unable to learn that this smut had had any injurious effect aside from darkening fruit, hay, etc., and interfering with the sale thereof.

It impressed me forcibly that so long as this substance is observed and so long as these ranchers have no reason to assume that it is due to any other agency or cause than the smelter, they will always consider the smelter is doing damage, the presence of this substance being tangible evidence that the fumes are carrying that far, from which it follows that the poisonous components of such fumes would also be carried over their lands; that is, the psychology of this situation renders it desirable to have some effort made to ascertain just what this substance consists of and the source whence it comes. There is nothing emitted by the smelter that could produce such an effect.

CONCLUSION AS TO DAMAGE TO LANDS AND CROPS.

From my interviews there is nothing, in my judgment, upon which to base a finding that the Selby smelter has been doing damage to lands or crops, either now or in the past. The region has suffered from three dry years, so there has not been very much of a crop of any kind, as a result of which the farmers have not had so much opportunity to dispose of their crops in the market, so that little or no evidence is available as to whether the smelter depreciates the price of crops. The prejudice that existed against hay on account of the presence of "lead deposits" seems largely to have disappeared, although it is said to still persist to some extent, both in the local markets and in the city market. Witness No. 1 was the only man who complained of this condition at present, but his complaint plainly related to previous years, since he has had to buy hay for his cattle in the last couple of years. Witnesses Nos. 12 and 25 mentioned it with reference to several years ago, but the others made no complaint on this score. The "lead deposit" which is alleged to have caused damage to horses in the past, does not appear to have injured vegetation. The only effect produced by it was to curtail the market for crops or else cause a slightly lower price to be given. The peculiar thing in this connection is that farmers claim that horses kept inside and fed this same hay were not affected. It was only the horses left out on the range that grazed when the heavy morning dews were present that were affected.

INTERVIEWS WITH RESIDENTS OF BENICIA.

These interviews were had in the early part of September of this year (1913), so that the expressions of opinion relate only to conditions up to that time.

Before discussing the evidence, it seems advisable to consider somewhat at length certain features as I encountered them, which have a direct bearing upon the evidence and the weight to be accorded same.

In the first place the majority of those interviewed manifested a certain restraint in discussing the smelter and its operations, which is plainly to be observed in the transcript of testimony. The caution and reserve thus manifested account in part for the somewhat equivocal characterization and description of conditions or improvements therein.

This attitude is the natural outcome of the situation that has been developed in Benicia. For approximately 10 years a more or less active agitation has been going on against the Selby smelter. The agitation began with the farmers who have been the most bitter complainants all along, and who aroused the sympathies of the citizens with their declarations of inability to raise crops or to keep horses. The frequency with which horses died, some of them on the main business street of the town, together with the distressing blowing or roaring that was characteristic, did more to arouse the community to action than any other one factor.

During these 10 years all sorts of rumors and statements have circulated as to the effect of the smelter smoke on lands and vegetation, animals, and human beings. These statements and claims have been so persistent that many are inclined to believe the smelter capable of most any form of injury. Some people, because of the extent of the agitation, attributed all kinds of ailments to the smoke, and complained, and complained bitterly, when others could not notice or perceive anything in the air. This has led to the belief that some persons can notice the fumes and are affected by them when others are not, and naturally there is a hesitancy when some complaint still exists to assert that the smoke is wholly absent when others complain, and this leaves some degree of doubt in the minds of many as to the improvement effected.

Again, there is a quite general feeling that although an injunction against the operation of the smelter has been in effect for five years, yet the smelting company with unlimited means at its command has been able to fight off the enforcement of it until now, and that the community is waging a hopeless fight against a rich and powerful corporation. It is felt that the commission is only an agency of the smelter to aid it in procuring a modification or removal of the injunction. With this injunction out of the way, it is felt that the smelter would be at liberty to operate as it pleased, and conditions would soon be as bad as before. Naturally, then, there is some resentment at this, and a feeling that whatever advantage or control is now had over the smelter must be retained, which colors opinions or statements as to conditions.

Again, the smelting company has had several agents in Benicia who have gone about asserting that the alleged smelter smoke was in

reality oil fumes. They made sufficient converts to stir up quite a bitter controversy on the subject, and have succeeded in confusing many people, so that many of them say they are unable to tell whether it is oil fumes or smelter smoke that bothers them. These agents tried to conceal their connection with the smelter, won the confidence of various persons, and gained expressions of opinion which subsequently were used against them. This has led to a suspicion of every stranger who goes around seeking information, and has begot a natural caution in spite of the apparent bona fides of the mission, which manifests itself in the evidence. Furthermore, some of the residents have been so bitter against the smelter that those who have not been particularly annoyed hestitate to take issue with them, and are led to qualify their statements or views as a result.

The combination of these factors is responsible for this general attitude, which was observed and remarked upon in the beginning, and helps to throw some light upon the evidence.

SMELTER SMOKE, DUST, FUME, AND GASES.

The same inability to furnish data as to the frequency of the smoke that had been encountered among the ranchers was found to exist in Benicia itself. A few persons only had kept notes of the times when the smoke had been observed, but not one of these persons had noticed the smoke more than four times. Witnesses Nos. 40 and 41 had noted the smoke four times, witness No. 50 three times, and witnesses Nos. 51 and 52 two times.

No one could go about and listen to the testimony of these varied witnesses and receive any idea or impression that conditions were bad or had been bad during this year, or that the smelter constituted a public nuisance. The manner in which it was asserted that conditions are "nothing like as bad," "not bad," etc., would clearly convey the impression that the witness did not consider that conditions were at all bad, or gave ground for complaint. At the same time this variance in the modes of expressing the opinions of the witnesses regarding present conditions makes it difficult to work up a statistical analysis of the evidence on this point.

My firm conviction is that no fair-minded person in the city proper considers that the smelter has been a nuisance during the present year. The general feeling among business men and others whom I interviewed was that conditions were all right now, if the smelter continued to be operated as it had been during this year. There seemed to be a lively dread, however, that conditions might become worse if the commission reported that the smelter was not violating the injunction, and the smelting company succeeded by reason of such report, or by any other means, in having the injunction removed or substantially modified. There are a few who are not willing to say

that the smelter is not a nuisance now, and who consider that the smelter is a nuisance at such times as the smoke comes, but these persons do not state that the smoke has come with anything like sufficient frequency to constitute a nuisance within the meaning of the decree and judgment.

I believe the following expressions of opinion fairly represent the general feeling of fair-minded persons.

Witness No. 40 says:

If the smelter continues to operate as it has operated in the past seven or eight months, there can be no reason to complain on the part of the people of Benicia. For my part, I don't believe there is a man, woman, or child in Benicia who, if they told the truth, would not have to admit that it (the smelter smoke) was not anything like it used to be. Not anything like. No one can say anything different.

Witness No. 41 says:

The smelter has given us practically no trouble this year. I don't think anybody has any ground for complaint the way things are now.

Witness No. 53 states:

I don't think any fair-minded person could enter any serious objection to conditions as they have existed in the last seven or eight months.

Witness No. 54 says:

If the smelter keeps things no worse than they are now, it is not so bad.

Witness No. 55 says:

We still get the fumes when the wind is right, but nothing like we used to get them. I have not heard much complaint on any side lately. A fellow ought to be able to put up with a little inconvenience anyhow.

Witness No. 56 says:

There is no serious cause of complaint, so far as I am concerned, with the sulphur fumes; in the last two or three years they have not bothered me any.

Witness No. 57 says:

The fumes are reduced in quantity to such an extent that I do not notice them unless I pay particular attention. * * * I have not noticed them very much this year. * * * It is not as noticeable as it has been in the past. In the last three or four years there has been a noticeable improvement.

Witness No. 58 says:

I have not smelled it at all for the last two or three years. If a man is to be honest and frank, he must admit it has been eliminated. * * * No one can complain the way things are now.

Witness No. 59 says:

People are willing to suffer this little that they are getting now, but the majority of them are afraid that after the commission is dissolved the smelter will try and have the injunction removed, and then will proceed to give us the same old dose again, which would mean the spending of thousands of dollars again to fight them. * * * If Selby continues to operate the way it is now, and there was no way to come back at us, people would not kick.

Witness No. 60 says:

I don't think there is any doubt but that there has been a great change. In fact I am satisfied with conditions the way they are now, without waiting for the recommendation, report, or finding of the commission. If they do no worse than at present we should have no reason for complaint.

Witness No. 61 says:

If conditions get no worse than they are now, then I am entirely satisfied. If we get it a day or two, what harm does it do? I am perfectly satisfied with conditions as they are now, if they do not get any worse.

These opinions might be multiplied, but I consider that they represent the views held by the greater portion of the citizenship of the community. The men whose opinions are given are representative citizens, including prominent city officials and business men. Of course, all the opinions are not expressed as emphatically, but, regardless of phraseology, the greater portion of those interviewed do describe conditions in such a way as to make it seem evident that their conclusions do not greatly differ. In fact, so far as the main part of Benicia is concerned, the testimony ran so uniform that I was thoroughly satisfied that the smelter does not now constitute a nuisance. While there were exceptions, of course, yet the great weight of the testimony supports this conclusion. It seemed to me that further testimony in the town itself would be purely cumulative, and would not lead to any other conclusion than would be reached with the evidence at hand. While this was true as to the main section of the town, I did find considerable complaint of trouble from the smoke in the section of the city out along by the shipyard, and from there on in to the old bridge by McKay's tannery. The houses here are directly along the water front where they get the full sweep from the straits.

An analysis of the testimony of 135 citizens of Benicia furnishes the following results, with respect to conditions this year (1913):

2 persons have not noticed the smoke at all.
10 persons have not noticed the smoke in two to four years.
6 persons have not noticed the smoke the last year or so.
13 persons have not noticed the smoke this year.
7 persons have not noticed the smoke for past five or six months (practically this year).

38 persons have not noticed the smoke this year.

20 persons have noticed the smoke not more than four times this year.
60 persons state the smoke is "not as bad," "not very much," "not near as bad," "very little," etc., or has not been noticed only "a few times," "several times."
6 think conditions are just as bad as ever or are still very bad.
3 get the smoke from once or twice a month to once or twice a week.
5 get the smoke "quite frequently," "quite a number of times," etc.
3 refuse to make any statement whatsoever.

Expressed in another way, 29 per cent have not noticed any smoke this year; 15 per cent have noted it less than four times,

while 44 per cent find conditions "not nearly as bad," etc.; 88 per cent accordingly have either not noted the smoke at all, or have observed it not more than four times, or find that present conditions are "not nearly as bad," etc. Only seven persons, or 5 per cent, claim that conditions are as bad as ever, while eight persons, or not quite 6 per cent, claim to get the smoke rather frequently.

As stated previously, there seemed to be more general complaint of the smoke this year, as well as in past years, in the exposed stretch of road from the cove by Carty's up to the Gould place, where the road makes a sharp turn from K Street into J Street, than elsewhere. Some twenty families live along here.

Of these families, witnesses Nos. 45 and 68 are the only ones claiming not to have noticed the smoke this year; witnesses Nos. 48, 69, 70, and 71 have noticed it only a very few times—two or three, witness No. 69 claims; witnesses Nos. 67, 72, 73, and 74 claim to get it once in a while. Witnesses Nos. 46, 64, 65, 66, 75, 79, and 80 claim that conditions are as bad as ever and that the smoke comes with great frequency; witnesses Nos. 76, 77, 78, and 14, all claim to have had it a number of times, the times not being specified.

Of these people, witnesses Nos. 14, 46, 64, 65, 66, 75, and 79 are the only ones apparently who claim that the conditions are bad. Of these families, it appeared to me that the testimony of witnesses Nos. 45, 48, 67, 68, 69, 70, 71, 72, 74, 81, and 82 gave the fairest view of present conditions, and I believe any conclusions based on their combined testimony is the correct one. It is not possible to judge of the strength of the smoke, since some people seem to be much more sensitive to it than others and since the witnesses could not be made to express a positive opinion.

Of these 20 families, 11 have not noticed the smoke at all, or only "a few times" or "once in awhile"; 5 claim that the conditions are "as bad as ever" and that the smoke comes with great frequency; and 4 claim to have had the smoke "quite a number of times."

There is a greater variance of opinion in this small section than elsewhere in Benicia, but, taking into consideration all the evidence and the impressions created by the various witnesses, I believe that while they may have had the smoke a few more times than in Benicia proper, it has not been a general nuisance, or been so severe or continuous as to interfere with the comfortable enjoyment of life and property. That is my personal conviction, notwithstanding the more apparently numerous bitter complaints. Witness No. 14 exhibited deep resentment against the smelter, but this was clearly inspired by conditions in years past; witnesses Nos. 46, 64, and 77 are all ailing women, and their physical condition seems to have influenced their views and judgment. The statements of witnesses Nos. 65, 66, and 75 seemed exaggerated to me, and are opposed to the testimony of their neighbor, witness No. 67, and the statements

of their employer, witness No. 81, and that of other workmen at the same place. The statement of witness No. 79, in my judgment, is not dependable, and is contradicted by that of his immediate neighbors, witnesses Nos. 68 and 82, while the statements of witnesses Nos. 73 and 76 are not consistent.

DATES WHEN SMOKE WAS OBSERVED.

The only dates that were given to me as those upon which the smoke had been observed follow:

Dates on which smoke was observed.

Date.	Time of day.	Observer.
1913.		
May 23	Forenoon	Witness No. 50.
June 15	Afternoon	Do.
June 19	Early morning	Do.
July 5	Midday	Witnesses No. 51 and 52.
August 4 or 5		Witness No. 83.
August 18 or 19		Witness No. 15.
August 23		Witness No. 8A.
August 25		Witness No. 12A.
August 28	No time of day specified	Witness No. 84.
August 29	Night	Witness No. 85.
Do	Forenoon	Witnesses Nos. 84, 59, 40, 51, and 52.
August 30 or 31		Witness No. 26.
September 3		Witnesses Nos. 64, 66, and 88.
September 2 or 3		Witness No. 22.
September 4		Witnesses No. 75 and 65.
September 5		Witness No. 89.
September 6		Witnesses Nos. 90 and 91.

Incomplete as the above list of dates is, it shows some interesting comparisons. Witness No. 50 and witnesses Nos. 51 and 52 claim to be very sensitive to the smelter smoke, yet the former has three dates on which he was troubled with the smoke and they were not, while the latter were troubled on two days that he was not. Witness No. 85, who occupied a room at the Anderson house, claimed to have been awakened during the night of the 29th of August by the smelter smoke, which caused him to cough for fifteen minutes or more. I did not smell anything, or suffer any annoyance, although I had a room with a like exposure. This witness is the only one who mentioned this to me, and he and his wife were the only ones in the house to be so affected. Witness No. 84 claims to have noticed it on August 28, but none of the other men on board the ferry steamer mentioned it as being present on that date, nor did witness No. 92 with whom he boards. August 29, several persons mentioned having observed the smoke, namely, witnesses Nos. 40, 51, 52, and 59, but with three exceptions these are the only persons who made mention of having observed the smoke on that date, although I saw most of the people in the town subsequent to that date. The three exceptions are persons who claimed at the time of the interview to have noted the smoke the previous week, but could not name the day or date,

but did say it was the latter part of the week, so that it is assumed they did notice the smoke on this date.

Witnesses Nos. 12A and 15 live across the road from each other, yet the former noted the smoke on August 18 or 19 but not subsequently, while the latter noted it on August 25 for the first time in a month. On the other hand, witness No. 8A noted it on August 23 for the first time in a year, but her nearby neighbors whom I saw did not make any mention of the smoke being present at that time, although I interviewed them only two or three days subsequent thereto.

Again, witnesses Nos. 22 and 26 are neighbors, their places adjoining; the latter noted the smoke on August 30 or 31, while his neighbor did not; witness No. 22, on the other hand, noted the smoke on September 2 or 3, while his neighbor did not.

Witnesses Nos. 65 and 75 claim that the smoke was present on September 3 or 4. I interviewed every one along that road on the 5th, yet with the exception of witness No. 64 no one claimed to have noticed the smoke on those days, which it is reasonable to suppose they would speak of if observed, owing to the recent prevalence of the smoke. Witness No. 64 claimed to have noticed the smoke on the 3d but not on the 4th.

PERSONAL OBSERVATIONS.

On the 28th and 29th of August, when the smoke was claimed to be present, I was out among the ranches and was unable to perceive any trace of sulphurous acid gas in the air. On September 3, the date on which witnesses Nos. 22, 64, 65, and 75 claimed to have noticed the smelter smoke, I was in Benicia and was absolutely unable to perceive anything. While interviewing witness No. 88 at the Kullman-Salz tannery on that date, he declared that "the air was pretty heavy with smelter fumes." It was imperceptible to me, and also to two other of the workmen to whom I spoke. On September 5, while interviewing witness No. 89, she declared "the smelter is giving it to us heavy to-day." I did my best to detect a trace of sulphur dioxide, but could not. The following day, while at the Anderson for lunch, witnesses Nos. 93 and 94 informed me that the smoke was present, and very noticeable. I walked down to the water's edge in direct line with the smelter, and could not see smoke coming up the straits, nor could I obtain any trace of it.

During my stay in the region, I noticed the smoke on just two occasions; once while driving along below the shipyard toward Benicia I caught a faint trace of it, but was unable to get another whiff, although I drove for a quarter of a mile in either direction in the endeavor. This was on August 26, when no one claims to have observed the smoke. The other occasion was with Mr. Gould and Dr.

Franklin, of the commission, when with a high wind blowing we caught a faint trace of sulphur dioxide. While I was at the ranch of witness No. 16 he claimed that there was a slight sulphur odor in the air. It was too slight for me to notice. Mr. Wells and I were at witness No. 78's place on September 30, at which time the witness claimed to detect "sulphur fumes." Wells and I did our best to detect sulphur dioxide, but without success.

These experiences of my own confirm what many of the residents of Benicia told me, namely, that frequently other people would remark that the smelter was bad when they could not observe a thing. The great diversity of dates shown, with the fact that only one or a relatively few persons observed them on the particular dates, and the further fact that one person in a neighborhood notices them while another or others do not, leads to the conclusion either that the sulphur gases are so diffused by the time they drift the 5 miles from the smelter that only faint traces can be had now and then, which one person might observe and another would not, or else it is imaginary. If what was imperceptible to me is called a "strong" or "heavy" fume, as it was by witnesses Nos. 88 and 89, then it does not appear to me that the smelter can be much of a nuisance. It should be kept in mind that no one claims now that the smoke is present for hours, the way it was years ago. My own conclusion is that small quantities of sulphur gases, sort of stray whiffs, can still be noticed at times, which would account for individual as distinct from general complaint. This conclusion is supported by the fact that there does not seem to have been any one day or part thereof on which the smoke was so bad as to give general complaint.

I have observed the smoke from the Selby stack drifting down from the top of the stack and going up the straits, but I have never seen it travel for any great distance during the limited time I was in the region. There seems to be a characteristic haze observable along the shores and back toward the hills on both sides of the straits, which is added to by the volume of smoke from trains, boats, and from other plants along the shores. Sometimes this is light bluish in character. Unquestionably this is considered to be smelter smoke at times. For example, on August 26 witnesses Nos. 15 and 95 pointed out this condition that I term "haze" and observed that it was smelter smoke. Witnesses Nos. 11 and 12A declared it was not smelter smoke, which I knew to be the case, as I had just driven over from Dillons Point and had seen the smelter smoke driving back along the Contra Costa shore. Quite a few times this condition in the straits was pointed out to me as smelter smoke when it could be seen drifting over the White ranch or over the tules beyond. Looking over on the Contra Costa shore the same condition could be observed, and the haze seemed as dense on the one shore as the other.

PSYCHOLOGICAL ASPECTS OF CONTROVERSY.

These and other experiences, as well as observations in general, have served to convince me that the question of the Selby smelter smoke at present is to a large extent a psychological one. It is my firm belief that so long as a certain class of the residents of the district know that the smelter is operating, and so long as they have ocular evidence that smoke or gases are coming from the smelter, they will continue to believe that cause for complaint exists. I believe that I am normally sensitive to sulphur dioxide, but when persons can observe it when it is imperceptible to me and to others, it must be believed either that they have superior powers of observation, in other words, are supersensitive to the fumes, or else are suffering from an honest but nevertheless mistaken belief. So long as occasionally they perceive smoke coming from the smelter stacks, they will believe that haze or fog contains smelter smoke or is smelter smoke, and will continue to find annoyance or damage. Every condition out of the ordinary, for which no explanation can be given within the limits of their experience, will be attributed to the smelter. Perhaps as good examples of this as any are the following cases:

Witness No. 96, a dock laborer in the employ of the Southern Pacific Co., and a man who has done the hardest kind of work for years, has had, for seven or eight years, some kind of stomach trouble of such a severe character that he has been unable to keep food on his stomach. He has doctored for years without relief, and has been told it is due to ulceration of the stomach. Notwithstanding this, he is firmly convinced the smelter alone is responsible.

Witness No. 46, a sickly, anemic woman, has been ailing for years. The doctors have pronounced her ailment different things, but she "knows" it is simply the smelter that is responsible.

Witness No. 97 has "one lung entirely gone," as it is termed, due to tuberculosis. She has a distressing cough in the mornings and finds it difficult to breath in the early morning air. This is due to the smelter, and her husband is so distraught with her illness that he can see clouds of sulphur smoke rolling up the straits every morning (see testimony).

Witness No. 98 lost a cow and calf this summer. She was not sure whether it was the smelter that killed the cow or not, but she did know "the smelter smelled awful bad" the night the cow died.

Witness No. 99 has developed a little throat trouble in the last two years, for which he blames the smelter, notwithstanding the fact that he has found the smoke much less in that time, in fact, has not noticed it very much at all.

Witness No. 100 has two little girls who have had quite a little throat trouble of late. He does not know whether to blame the

smelter or not. Still he has the idea that the smelter might be responsible.

Witness No. 77 has a white mold on her plants which she is inclined to think is due to the smelter. If there is anything in the world that sulphurous acid gas would not cause, it is mold.

Witness No. 92 has had trouble with her roses, the leaves seeming to turn black in a day, not covered with a black deposit, but turning black over night. This, she is told, is due to the smelter.

Witness No. 22 has been living at his present place of abode for three years. He finds that the trees do not have as much foliage as elsewhere, and that the fruit does not attain the same perfection. These three years have been dry years, little or no rainfall in that region, yet the smelter is responsible.

Witness No. 64 was sick about a year ago; she did not know what was the matter with her, but her physician said it was the "smelter."

Witness No. 87, in the rolling room at the tannery, where a considerable amount of fine dust is given off from the tanned hides, had eye trouble several years back. His physician also told him this condition was due to the "smelter."

These are not all the cases by any means, but they are sufficient to illustrate what is meant when it is said that the question is to a great extent a psychological one. So long as visible smoke is permitted to be discharged from the stacks, a great many people are going to continue to believe that harm is being done—if not visible harm or damage, then some insidious form of damage that will manifest itself after awhile. There is no question in my mind but that there are people who, because they know the smelter is still discharging visible smoke, feel that they must smell it at times. In the same way some of those who are ranching, so long as they are aware that smoke is coming from the stack at the Selby plant, will continue to feel that damage must still be done, and inexplicable conditions, such as the failure of vine graftings to take, decreasing yield from fields, the failure of sheep to multiply as they should, the failure of mares to foal, etc., will be laid at the door of the smelter. Convictions of this character, which are the result of years of agitation, of the circulation of all kinds of baseless rumors of harm and injury, are extremely difficult to change.

RESUMÉ AND CONCLUSIONS.

SMOKE IN 1913.

There seems to be no doubt but that the smelter smoke has been observed in Benicia this year (1913), but only a very few times, not exceeding a half dozen in number, according to the great majority of those interviewed, and these at varying dates and times. The smoke when present does not seem to have been generally observed,

some noticing it and others not. This leads to the conclusion previously expressed that the sulphurous acid gas is so diffused when it reaches the main part of the city that it is not strongly noticeable, and is observed only for a very limited period. Those who are affected with throat troubles seem to find a whiff of the sulphurous acid gas to be very irritating, though it might not be observable by others. It seems, also, that the smoke is so diffused that its presence is detected more by this irritation than by the sense of smell. Even out along the road by the shipyard it does not appear that the smoke is noticed at the same time by all who live along there, nor do the reports of the effects produced coincide, some claiming to be very much distressed, while others are not bothered particularly.

I was able to find no evidence of any particular day when people generally were affected, although it would naturally be expected to find such evidence if the smoke was very strong. Again, if the smoke came as often as alleged along by the shipyard and was as strong as claimed by witnesses Nos. 65 and 66, for example, one would naturally expect to find that the smoke had carried back to the ranches beyond, but there does not seem to be any evidence of this sort. I do believe, however, that they have had traces of the sulphurous acid gas more frequently in that section than in the city proper.

CONCLUSION.

Taking the evidence as a whole, and as stated in the beginning, I can not conclude that the smelter smoke, fumes, or gases have been such as to constitute a public nuisance so far as the city of Benicia is concerned, during this present year, and can not believe that anyone could reasonably find otherwise.

SMOKE IN 1912.

With respect to conditions in 1912, the testimony is not quite so consistent. There appears to be a greater difference of opinion with respect to conditions in that year. Out of 122 people, 17 comment on the fact that this year is better than last year, while the great majority of those who find an improvement in conditions link the last couple of years together in speaking of such conditions. It was as difficult to get any data with respect to the frequency with which the smoke had come in 1912 as it was for this year. This was to be expected, as if people could not remember how many times they had had the smoke this year, they would hardly be able to recall how often they had had it in previous years. The best that could be done was to get an expression of opinion couched in general terms.

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RESUMÉ AND CONCLUSI[illegible]

SMOKE IN 1913.

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An analysis of the testimony of 122 persons gives the following results:

6 persons did not remember what conditions were.
22 persons did not notice the smoke during that year, or for a year or more prior thereto, or were not "bothered."
60 persons found the smoke "not as bad," "not as much," "not bad," "much better," "very little," etc.
16 persons described conditions as better than previous years, but as still affording cause for complaint.
18 persons found conditions just as bad as ever, or still bad, etc.

Expressed in percentages, 16 per cent found conditions just as bad as ever or "pretty bad." Thirteen per cent found conditions better than in any preceding year, but still not satisfactory. Eighteen per cent were not bothered or did not notice any smoke at all, while 49 per cent found the smoke "not bad," "not as bad," "not very much," etc. Four per cent did not recall whether 1912 was a bad year or not. The year could not have been a very bad one or these persons would have had some distinct recollection of that fact. Thus it may be said that 71 per cent did not notice the smoke at all or did not find conditions very bad.

I feel that figures such as these give a wholly unsatisfactory view of the situation that existed last year. Expressions like "not as bad," etc., when used as descriptive of conditions have to be read in connection with the rest of the testimony to get a correct line on what is actually meant thereby.

The only conclusion which can be reached would seem to be that the majority of persons did not find conditions on the whole to be bad. The majority of persons affirm that they have not been as bad in the last couple of years. While a number claim the smoke was bad during the year, they do not assert that it was bad continuously, or more than a few times. That there were "some" bad days last year, or that there were a "few" days when it was bad was the most that I could drag from anyone. It appears to me from this testimony that the conditions last year must have been very similar to conditions this year, and that occasional whiffs only were had at varying intervals, observed only in comparatively small areas. It was impossible to learn whether the day that one person claimed was bad last year was a subject of general complaint, since no records seem to have been kept on the subject any more than they were kept for the present year. I am thoroughly satisfied, both from my experiences and the conflicting statements, that many people in Benicia are inclined to call the smoke bad or term a day as bad when they can detect the slightest trace of sulphur dioxide, so that when it is said there were a number of bad days, it throws little or no light on the strength or duration of the smoke and the degree of offensiveness, if any, that would normally be caused.

The number who signed the petition in November, 1912, praying for the closing down of the smelter and the enforcement of the injunction, gives no reliable index of the sentiment of the community. Two hundred and forty-seven names are signed to the petition, of whom I interviewed some 70. In many instances the name of both husband and wife is affixed to the petition. When I had interviewed either one, it seemed necessary to interview the other, so that the number interviewed would amount to considerably more if the one could be considered as testifying for the other. The majority of these persons give testimony which is at variance with what would be expected of those signing such a petition, and confirm the belief that they signed merely because approached and asked to sign, rather than because they felt that conditions were so bad as to require it. I note the names of a number of persons who testified that they either did not notice the fumes at all, or else noticed them but very little, among such persons being: Witnesses Nos. 10, 30, 31, 43, 44, 45, 68, 69, 71, 88, 99, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, and 111.

CONCLUSION.

Viewing the evidence in all its phases, I can not find that there are sufficient grounds for concluding that the smelter smoke, fumes, or gases constituted a nuisance during the year 1912. That it caused some degree of annoyance at odd times to some of the residents must be accepted, but that it amounted to a genuine nuisance, interfering with the confortable enjoyment of life and property, is not established, and this notwithstanding the presentation of the petition.

SMELTER SMOKE AND OIL FUMES.

The evidence seems to bear out to some extent the contention of the smelting company to the effect that oil fumes contributed in part to the degree of nuisance that previously existed. The fact that most impresses one is the number of those who claim that the smoke was so oppressive in the nights and early morning up to two or three years ago. Out of 137 persons, 41, or a little less than one-third, complained of being awakened during the night or early morning by a stifling or choking odor that would arouse them from sleep and compel the closing down of the windows, or of being troubled with heavy, oppressive fumes in the early morning hours. These people have had little or no trouble of this nature in the past two or three years. This fume or gas that prevailed at that time seemed to furnish the cause of the most bitter complaint, and since the elimination of same, conditions are found to be greatly improved. Some of the more pertinent evidence along this line is set forth below.

Witness No. 112 claims that they do not get the fumes in the night now so much as during the day. Up to a couple of years ago

they used to get a "very heavy and oppressive odor" which would make his wife vomit. "The odor was something different from sulphur, altogether. Was a pungent sort of odor; would dry up the throat and nauseate you." When they began to move around the house in the morning they would find the house full of it. They have had very little of that lately, although his wife complained of being awakened out of her sleep one night this summer.

Witness No. 110 had a great deal of trouble up to three or four years ago. Was troubled worse in the morning with a "very disagreeable fume," which caused "a choking sensation," so that "if you coughed much it would make you throw up or something;" was not altogether "a sulphur fume;" what else was mixed with it he did not know. His son had to move out of town on account of it, but in the last two or three years has not been bothered at all.

Witness No. 99 has not been troubled "much" in the last two or three years. He used to be compelled to get up about 5 o'clock in the morning and close the windows on account of the fumes. "The effect was more of a sickly fume—more of a nauseous fume; would be so bad I would have to get up—would wake you up. The odor was not like that given off by an oil-burning locomotive when going through a tunnel. I do not see why they let loose something in the morning the way they have done. They seemed to shoot it to us in the morning. The morning is the only time it seemed to affect us to such a degree. The fumes do not seem to be sulphurous; seemed to be something different."

Witness No. 113, an old mining superintendent, a graduate of Freiburg, and formerly assistant superintendent of a large Montana smelter, gives some valuable testimony along this line. Three years ago he was awakened by a choking sensation, compelling him to get up and place a wet towel over his head in order to sleep. The odor was altogether different from any "sulphur or lead fume" he had ever noticed in or around any smelter, and seemed to him to be an odor given off in the refining of oil. If this odor had continued up to the present time he would not live in the town for a minute.

Witness No. 114, an experienced copper miner, stated that up to the last year or so they had a fume in the early morning that he could hardly stand, and that would have driven him out of town if it had continued since that time. This fume was altogether different from any "sulphurous fume" he had ever experienced in and around Butte. In his own words, "This smell that I got here (in Benicia) was a wholly different odor (from sulphur dioxide). I could not have stood this kind of a fume that we used to have here; could not stand it. It used to bother me a great deal; the whole room used to be full of the smell; would nearly suffocate me. The smell was something heavier, more oppressive, than sulphur fumes."

Witness No. 115 used to be troubled in the early morning with a nauseous fume, but finds that this has disappeared in the last two years, though occasionally he notices something in the air that causes irritation of the throat and a cough. "I must say that the fumes are not as bad as they used to be. The smell is nothing like it used to be. The smell has almost disappeared, but the irritating effect still remains * * *. It was a very oppressive odor and would even affect me in the stomach, it would come so strong. In the last two years I have not noticed this nauseous odor as much as before; it might be a little longer than that. I have not experienced the nauseous odor in a long time."

Witness No. 102 four and five years ago worked out on the ranches, and states that they used to be troubled in the early morning with a heavy choking odor that would make them tie handkerchiefs over their heads in order to breathe. In his rough language he describes it as follows: "Was a sort of a heavy rotten smell; a d——n strong stuff, whatever it is. We used to get the same smell around town two or three years back. I could not tell what smell it was. It was a rotten smell, whatever it was." He has not noticed this in the last two years.

Witness No. 116 complained of a fume several years ago. He says: "It seemed to be a very heavy odor; seemed to choke me up. A kind of a staggering rotten smell that I used to get in the morning."

These quotations seem sufficient to indicate that there was something else present in the atmosphere up to a period variously placed as from two to three years ago, which caused a great deal of annoyance and contributed materially to the nuisance which existed. In addition to these extracts, the testimony of witnesses Nos. 47, 53, 57, 68, 108, 109, 117, 118, 119, 120, 121, 122, and 123 throws further light on this condition and supports the above conclusion. The testimony of a number of others suggests the same conclusion, but is not as direct and explicit.

Two-thirds of those interviewed find conditions improved in the last two or three years and the nuisance lessened. My own conclusion from this testimony is that the fumes which were complained of at this time of day constituted the greater part of the nuisance alleged to exist. Those who complained of the fumes at other times in the day do not mention this stifling, choking feeling, and do not make the same bitter complaint as do those who speak of these night or early morning fumes.

The odor described and the effects produced are distinct and different from those attributable to smelter smoke. At the same time the coughing and irritation would seem to be due to sulphur dioxide, or at least to be characteristic of it. Many who spoke of this former prevailing condition complained both of the coughing and irritation as

well as the stifling, oppressive odor. The fact remains, however, that the so-called "smelter fumes" have not been as noticeable in the past two years and do not seem to have been as offensive.

Whether any oil fumes contribute at the present time to what complaint of smelter conditions still exists can not be determined to any satisfactory degree. Only 31 persons out of 137 claim to be able to detect the oil fumes, and of these only 2 describe the odor as that given off in the refining of oil. The others declare the oil smells observed resemble either the smell of crude oil, the smell of burning oil given off by a locomotive, or else is like that observed when going past the refinery at Oleum. A number are so confused by the controversy that has raged as to the difference between oil fumes and smelter smoke that they do not know whether what they occasionally smell is the one or the other.

It is peculiar that of those who complained of the heavy oppressive odors in the morning and who noticed the fumes at other times in the day all claim that the smell was always the same. It is just the same kind of a smell now, though with very few exceptions they declare it is not as strong a smell. In a number of cases I could see that the witness felt I was trying to trap him by asking such a question. I found that the residents appeared to resent the idea of the smelter making the oil works the scapegoat, and this may account to some extent for the invariable response that the fumes are the same in character.

Approximately a dozen of those who claimed to be able to identify the oil fumes claimed that a number of people mistook the oil fumes for smelter smoke, but in every instance they were unable to give me any idea of the frequency with which the oil fumes had come, although they declared without exception that the oil fumes were observable but seldom. This means that approximately 20 per cent of those interviewed do notice oil smells, but their identification of these smells is not sufficient to establish that the smells observed come from the Oleum plant. This leaves it a matter of doubt as to what extent, if any, the oil fumes from the Oleum refinery contribute to such nuisance as may exist. If the stills are capped, and the ill-smelling fumes complained of came from the emptying of these stills as contended by the smelting company, then, unless occasional trouble is experienced with the capped stills, the odors therefrom would contribute but little to the nuisance. If the oil fumes do still come, they either are not recognized, or, if recognized, are not correctly described.

It is not a fact, apparently, that the complaint was confined to the early morning hours, as 47 persons spoke of getting the fumes during other times of the day. Either the oil fumes or odors were given off fairly continuously throughout the day, and were hence noticed at other periods than the night and early morning, or, what seems more

plausible, the sulphurous acid gases were observed at other times and at varying intervals by some people. To what degree, if any, the oil refineries along the straits added or add to the volume of sulphur dioxide or trioxide given off by the smelter is something to be determined. It is possible that they have added, and are adding, to it, even though the offensive odor may have been successfully bottled up. The complaint that did exist, speaking generally, with respect to conditions during the night and early morning has been largely, if not entirely, eliminated, and the time of such improvement seems to be coincident with the time when the stills at the oil works were capped. This does not mean that all complaint has been eliminated. Eighteen people claim to have noticed "the fumes" in the early morning of this year, although only five of them claim that "the fumes" were as strong or the effect the same as heretofore. These five are witnesses Nos. 46, 63, 65, 66, and 75. Witness No. 98 claims that "the fumes" last year were as strong and as bad as ever. Three persons claimed to be troubled during the night or early morning last year, but were not so troubled this year. "The fumes" now when noticed appear at any time during the day, no particular time standing out prominently, which is what would be expected if the annoyance is due to smelter smoke.

CONCLUSION.

The conclusion can not be reached, in my judgment, that the oil fumes, if present as claimed by the Selby Company, constituted the whole nuisance alleged to exist. Complaint existed at other times than nights and early mornings and has continued since. Some people seem, or claim to be, as much affected at rare times as before, though for shorter lengths of time. The ground for complaint appears so much less since the elimination of such fumes, however, that it is assumable that the injunction proceedings would not have been started if conditions had been as they are now, or have been in the past two years, provided the smelter was not emitting any greater volumes of sulphurous acid gas than it has in these years. This leaves out of consideration the damage to horses, which was a large factor in the trouble.

INJURY TO TREES AND VEGETATION.

There seems on the whole to be little complaint of injury to trees and vegetation in the city among those I interviewed. I was unable to learn of any damage that sounded as if it might have been caused by the smelter smoke. In both driving and walking about town, I examined the trees along the streets and in the various yards, but I could find no trace of what looked like a sulphur-dioxide burn. The evidence of smelter damage was nonexistent so far as my investigation went.

It has already been mentioned that witnesses Nos. 45, 46, and 47 claim that their orchards were killed some three or four years ago. Witness No. 48 also claims to have had trouble at that time. This damage was not a sudden damage but a gradual one, observable after a period of time. The trees died out on the side toward the smelter first. These orchards have not thrived since that time, and the first three witnesses believe that the smelter is still injuriously affecting them. The former is not quite certain on that point, however. Witnesses Nos. 65, 66, and 75 (one family) have a small orchard, which is doing poorly, and which they are inclined to think is being affected by the smelter, though they do not positively assert that such is the case. Witness No. 64 has a few young trees set out, which she claims are being killed by the smelter smoke. Witnesses Nos. 76 and 76A claim that the smoke has injured trees on their place and has prevented the growth of garden truck. The trees would dry up and the leaves shrivel up and drop off. This trouble has been less this year. Witness No. 69 claims that he has been unable to keep any fruit trees on the place, that something seems to cause the leaves to shrivel up and drop off on the side toward the smelter and then in a year or two the whole tree has to be dug up. He has never noted the damage as occurring at any particular time and has never noticed any sulphur-dioxide burn. Witness No. 77 claims the existence of a white mold is due to the smelter smoke. Witnesses Nos. 72 and 72A claim that plants and garden truck will not grow owing to the smelter smoke, that the vegetables do not develop and mature as they should.

There are a few other claims of this character, which it does not seem necessary to set out in full. Enough have been enumerated to make it evident that the claims of damages are wholly distinct from the claims usually made of smelter-smoke damage. While this fact is evident enough, there does seem to be such a prevalent feeling that the smelter is responsible for conditions of this character that it is worth while to ascertain, if possible, to what the condition can be attributed. The other persons who make mention of this sort of damage are witness No. 118A, vegetables and flowers; witness No. 89, fruit trees; witness No. 124, cypress and fruit trees; witness No. 92, rosebushes; witness No. 79, fruit trees. These persons are the only ones who mentioned damage to trees or vegetation. The noticeable fact in connection with this is that all of these persons, with the exception of witnesses Nos. 118A and 124, live out along the exposed stretch of road commencing just beyond Burke's saloon, or else live directly on the water front. Witnesses Nos. 47, 89, and 92 live along the cove near McKay's tannery.

During the trial of the case resulting in the issuance of the injunction, no mention was made of damage to vegetation in the city, and

there can have been little of it or mention would be made of it by those who have been prominent in fighting the smelter. Witness No. 40, who has a beautiful place across the street from where witness No. 92 lives, with a yard full of shade trees and flowers, makes no mention of any damage whatsoever.

CONCLUSION.

There is no evidence whatsoever in my judgment of any damage to trees or vegetation due to smelter smoke, either during the present year or during past years. It is evident that there was some peculiar condition prevailing about three years ago that injured fruit trees, but the description of it does not resemble smelter damage in any way. That the smelter is not a nuisance in this respect is beyond question.

DAMAGE TO SCREENS AND WIRES.

There is quite a little complaint to the effect that the sulphur smoke eats screening of all kinds and wire fencing, netting, etc. It is said that sulphurous acid eats out wire netting, fencing, and screening, so that it lasts only a year or two years at the outside. It is claimed that screens on the side of the house toward the smelter are affected, while screens on the other side will last a great deal longer. Appproximately a dozen people mentioned this form of damage, but in spite of this fact I am satisfied that it is a general belief or complaint from what witnesses Nos. 41, 101, and 125 told me. Witness No. 126, a competent metallurgist, connected with the Benicia Iron Works, claims that this condition is due to the fact that there is so much salt moisture in the air and that he has heard people speak of this form of damage and has laughed at them.

CONCLUSION.

Knowing the destructive effect of salt moisture-laden air upon screens, etc., and observing conditions in the straits and the bay, where a strong tide runs and heavy winds whip the tops of the choppy waves, it would seem that this might account in a large measure for the damage complained of. It is worthy of note that at the time of the trial, examinations of screens, etc., in Berkeley showed higher percentages of sulphurous acid than did similar tests of screens in Benicia.

OCCURRENCE OF SMUT.

There is practically no mention of smut so far as Benicia proper is concerned. Witness No. 112 of the Port Costa Lumber Co. complains that the lumber in the yard is darkened by some substance that seems to grime into the wood. His wife also complained that flowers and vegetables were covered with a black smut, but stated that this condition has been much better in the past two years.

The above was the only mention of this substance in the main part of the city. Witnesses Nos. 57, 101, 127, and 128 spoke of observing the smut on the ranches up to several years ago, but since that time they had not observed any or been in a position to observe any. Coming to the long stretch of K Street by the shipyard, there is more mention of this condition. Witness No. 65 thinks the smut is just as bad as ever, though he has not been out in the fields to work this year. Witness No. 67 also complains of the smut on stubble, etc., but thinks it is less than in previous years. Witnesses Nos. 45 and 69 also noticed it this year, but thought it was less. Both of these persons noticed it on trees and fruit. Witness No. 70 said they have had trouble with the smut up to this year. They have a small ranch and noticed it on the stubble. The others did not complain of it.

CONCLUSION.

The people in the city itself do not have the opportunities for noting the smut that do those living on the ranches. An improvement in the amount of smut present for the last year or two has been noted, though the evidence is not as explicit on this point as in the case of the ranchers. So far as the main part of the city is concerned, it is not observed to any extent whatever. The same connection between the oil fumes and smut would seem to be indicated that was remarked upon with respect to the situation on the ranches.

DAMAGE TO STOCK.

There is little mention of damage to stock in the city of Benicia since the construction of the bag house. Witnesses No. 60 and 60A claim to have lost a horse some six or seven years ago, the symptoms being the same as with the other horses that were "smelted."

Witness No. 119 claims that when he was ranching some seven or eight years ago, he lost eight or nine head of horses, for which the smelter paid. These horses could not be worked, and had a bloody secretion from the nostrils.

Witness No. 44, a butcher, claims to have lost a horse some seven years ago. This horse was "smelted" in his opinion.

Witness No. 73 claims to have lost four horses some four or five years ago. Three of these horses were put in the pasture in the fall of the year and died in three weeks' time.

Witness No. 129 lost two horses four years ago, the horses roaring and displaying the usual symptoms. The horses were left out in the pasture over night. The horses have been kept in the stable over night since and no trouble has been experienced.

Witness No. 75 claims to have lost two or three cows and a horse, owing to the smelter. The time was placed as "several years ago."

The animals "just choked up and could not breathe, the horses getting fat and the cows poor." The condition of the animals was "just what the veterinarians have said was caused by the smelter."

Witness No. 64 claimed she has lost a number of chickens, owing to the smelter smoke. These chickens were all troubled with a "cough" before they died. The trouble continues up to the present time.

Witnesses Nos. 76 and 76A lost a cow this year, but the loss is not attributed to the smelter. Eight and ten years ago they lost two cows, the cows falling down to skin and bones. Now they believe these cows were "smelted."

Witness No. 69 lost several horses about six or seven years ago. These horses had been turned out to pasture and were affected "like the other horses." He has an old horse now, about 27 years old, that he believes is "smelted." This horse is "short winded," but does not blow much.

Witness No. 128 lost a couple of horses about 16 or 17 years ago. These horses were affected the same as the horses on the ranch of Witness No. 8, where he worked some years ago.

Witness No. 130, a teamster, lost a horse seven years ago that he considers was "smelted." It "was affected like the other horses around here."

Witness No. 70 does not know whether the smelter killed a cow and calf for them this year or not. The smelter "smelled awful bad" the night both died.

Witness No. 63 lost a horse last year and has another horse that he considers has been "smelted." The horse that died developed a cough and rapidly became worse until it died. The horse he now has is developing a cough likewise. He considers that the smoke is the cause of it. The horse that died was fed on hay bought from one of the local ranches, but his present horse is fed on hay purchased from the outside, so that he does not feel certain how the horse contracted the affection.

This completes the list of stock injuries complained of.

Witness No. 127 lost one horse nine years ago, and has two horses now that were "smeltered" before the bag house was constructed, he being unable to recall the year. His theory is that the sulphurous fumes irritated the mucous lining of the horse's throat and that the horse died of strangulation.

On the other hand, witness No. 131 has put his horse out to pasture for the past 20 years and never experienced any trouble. Witness No. 137 has had stock grazing out for 10 years past and has never had the slightest trouble. Witness No. 123 has had at least 10 head of horses grazing in pasture for the past 40 years and never lost a horse. Witness No. 61 has had no trouble with stock put out to pasture by them, according to their head teamster.

CONCLUSION.

Outside of the horse which witness No. 63 claims to have been "smelted" last year, there is no claim of damage to horses in the city within the past four years. Witnesses Nos. 73 and 129 claim to have lost horses four years ago, but the other losses of horses mentioned, except that claimed by witness No. 63, are prior to the operation of the bag house. There is no claim of any other stock losses aside from the cows that witness No. 75 claims to have lost "several" years ago, and except also the loss of chickens claimed by witness No. 64, which hardly deserves to be taken seriously. It will be noted that these cows got "poor," which is suggestive, considering the alleged existence of tuberculosis in the region.

The Selby plant is clearly not a nuisance so far as injury to stock in Benicia is concerned at the present time, and there is no basis for assuming it has been a nuisance along that line within four years at least, if not longer.

The conclusions reached with respect to conditions in Benicia proper thus coincide with those reached as to conditions on the ranches within the smelter zone in every respect.

In an investigation of this sort, where it is necessary to obtain the information in a short time from each witness, owing to the inability or unwillingness of witnesse generally to grant an extended interview, and where the gist of the answers can be jotted down only while new questions are being framed and put, there are many things that are developed and that impress an investigator that are not and can not well be recorded in a transcript of testimony, although they influence the conclusions arrived at. For this reason some general impressions may not be amiss.

It seemed to me that the question of a smelter nuisance at the present time is hardly a question at all. There is not a shadow of a doubt in my mind that the smelter can not be considered to be a public nuisance as the situation has existed for the past year, looking at things sanely and reasonably. I was firmly impressed with the idea that comparatively few people consider it to be much now, though there is a natural reluctance to say so for fear it should again become such. It seemed to me that the situation has been exaggerated in Benicia in the past and is still to some extent. The situation is unique in the claims put forth of great annoyance, but with no damage to vegetation proven.

RECOMMENDATIONS.

It appears to me that a great many of the residents of the smoke zone are not going to be satisfied with any conclusion the commission may reach unless some attempt is made to confirm or disprove some

of the current notions with respect to the damage or injury wrought by the smelter.

There are five different classes of such damage alleged and it is recommended that each one be investigated.

The first is the alleged injury to fruit trees and vineyards. The effort here should be made to ascertain what is the cause of the general condition complained of, rather than to establish whether or not the smelter caused or contributed to it.

The second is the alleged "poisoning" of the land, so that crops will not grow or the yield is diminished.

The third is the damage to stock. Witnesses Nos. 12, 63, 69, and 127 all have horses living that are claimed to be "smelted." The colts belonging to witness No. 12 and the horse belonging to witness No. 63 are claimed to be recently affected and should be examined by all means, as should the sheep belonging to witness No. 18 and the cows belonging to witness No. 1.

It is a rather peculiar fact that the evidence at the trial does not conclusively establish what the horses claimed to be "smelted" did actually die from.

The fourth is the quick rusting and decay of wire screening, wire fencing, wire netting, etc., which is attributed to the smelter. This is considered to be tangible evidence of the capacity for harm of the sulphurous acid gases. This investigation should take in both the ranches and the city of Benicia.

The fifth is the origin and nature of this so-called smut or soot. This should be determined because of its fancied resemblance to lead and because of the psychological effect of the presence of this substance in the absence of knowledge of its nature.

A DETAILED STUDY OF STATEMENTS OF RESIDENTS OF THE CITY OF CONCORD, CONTRA COSTA COUNTY, CAL., AS REGARDS THE PRESENCE OF A SMOKE NUISANCE.

By C. B. Dutton.

I respectfully submit the following report of an investigation into conditions existing in the city of Concord, Contra Costa County, Cal., for the past three or four years:

The investigation was made at the suggestion of Mr. Braden, vice president of the Selby Smelting & Lead Co., who stated that it had been brought to his attention that there was considerable complaint in Concord about three years ago, but that this complaint has since ceased, although the smelter of the Mountain Copper Co. has continued to run as before. The idea was that the odor or smell which gave rise to that complaint might possibly have some relation to the oil fumes which, in his opinion, gave rise to the principal complaint in Benicia, inasmuch as the improvement was practically coincident with the capping of the oil stills at the Oleum plant.

The investigation was wholly negative as far as confirming this idea or belief is concerned. I arrived in Concord a few minutes before 11 a. m., having caught the 8 o'clock train from San Francisco, and left on the 6.30 train for the city. During my stay there I interviewed some 68 persons. Seventeen of these people had not lived in the town a sufficient length of time to be able to give me any information of value. None of these persons, however, had noticed any fumes or odors during residence in the city.

The testimony of the remaining 51 persons shows the following results:

32 persons never noticed any fumes or odors at any time.
9 persons noticed the fumes in Concord about three years ago.
2 persons noticed the fumes up to a year ago.
2 persons notice the fumes occasionally now.
2 persons complained of local odors such as sewer and slaughterhouse.
4 persons complained of noticing the fumes when driving toward Martinez a "couple" of years ago.

Of these 32 persons only 2 recalled hearing any complaint, but they were unable to tell me who the persons were that had complained, or in what part of the city they lived; the others did not recall ever having heard anyone make any complaint on the subject.

The above means that 38 out of 51 persons in Concord itself have no recollection of having noticed any fumes, odor, or smell attributable to the smelter or the oil refinery.

Of the 13 persons who have noticed such odors, all, without exception, say they came from Peyton (where the chemical works were located) or from the Mountain Copper Co. Several said that the fumes were worst when the Copper King smelter was running, which is a smelter of which I had not previously heard. This smelter was located around Bay Point, but just when it ceased to operate is something concerning which witnesses could give no information.

Eleven of these 13 persons identified the smell as sulphurous, the same as would be noticed at the smelter, and spoke of irritation and cough produced by the fumes. One, a druggist, called it a "chlorine" fume, while another could say only that it was a strong smell, the latter noticing this smell last year. Only three persons claimed that the fumes were very bad at any time, one of these persons claims still to notice the fumes, while the other two have not noticed them for a couple of years. All the others claimed that they noticed it but little; that it did not bother much. It is evident apparently from this testimony that the fumes were never much of any annoyance in Concord. Witness No. 1, a former mayor of the city, claimed there was considerable complaint several years ago, but he could not refer me to the persons who complained. Witness No. 2, a practicing physician, also made the same statement, but he could not recall who complained. I could not find very much evidence of this complaint.

It seems a little peculiar that there should have been more complaint three years ago than there is now or has been since, in view of the fact that the Mountain Copper Co. must be discharging as much sulphurous acid gas as before, if not more. Some reference was made to improvements that were made in the Peyton Chemical Works after the suit was begun against the companies some three years ago, and the elimination of the odor or smells, so far as most people are concerned, appears to date from that time. No recollection is had of any heavy oppressive odor that used to come in the room and stay there, or that was penetrating enough to arouse them from sleep, or that had a stifling effect. They all say it was not bad enough for that. Two persons say it was west winds that brought the fumes to them, while the rest say the winds were from the north or northwest, pointing in the general direction of the Bulls Head smelter and Peyton.

Four persons, among them witness No. 3, a leading merchant, spoke of the suit that had been brought against the companies by the supervisors, and said that an attempt had been made to include Concord in the fight, but that evidence could not be obtained show-

ing that it was a nuisance or that damage had been done, so that the attempt was given up. Two of these persons also said that the farmers who had made the greatest "holler" against the smelter had been unable to prove a case, and the suit had practically been dropped.

I also found that several of the townspeople referred to the farms nearer the smelter (Mountain Copper Co.) having been ruined, so that they would not grow anything, and this despite the fact that there are no lead deposits to "poison" the soil, as is claimed across the straits in Solano County. There does not appear to be a widely prevalent opinion of this sort, as the soil around Concord is remarkably fertile, a deep rich loam, according to general accounts, and crops are uniformly good.

So far as the times when these fumes were noticed is concerned, two persons claimed they were noticed along in the early evening, while the others say they came at all times. They were never present for any length of time, an hour being the most that anyone claimed. The others say they would just smell it for a short time.

The only thing that suggests the possibility of Mr. Braden's supposition being true is that the odors have been perceived only seldom in the past two years, and that most people who did notice them have not noticed them since. There is nothing else in the description of conditions that suggests the odors or fumes given off in the refining of oil. It seems more plausible that it came from the combined plants on the bay, rather than from Oleum, since there is more of a natural draw in that direction, while high intervening hills would have a tendency to prevent the oil fumes from carrying that far. There is an oil refinery at Bay Point, but whether that ever entered into the problem is indeterminable from the evidence at hand. There is no reason to believe it did, however.

There was one thing that impressed me, and that is, in this town of Concord, where it is evident there has been no nuisance worthy of the name, it would seem, on the face of the evidence, that it would be possible to reproduce exactly the same variety of opinion, and even some of the same vigorous complaints, that exist in Benicia to-day, where a nuisance has been declared to exist and is still claimed to exist.

In my judgment there is nothing in the way of tangible evidence that throws any light on the Selby problem.

CONDITIONS OF PLANT LIFE IN THE SELBY SMOKE ZONE, JANUARY 1 TO JULY 1, 1914.

By J. W. Blankinship.

INTRODUCTION.

It is to be noted that this investigation was not begun until January 9, 1914, in the district in question and was ended July 1, and that the time at my disposal for the work was very limited. I was able to give only 18 days of actual field work—an average of one examination each 10 days, while hardly more time was available for laboratory work on the material collected. Fortunately I had previously been over this district on several occasions and so was fairly well acquainted with the local conditions and the injuries commonly attributed to smoke. Consequently less time was required for my work than would ordinarily have been the case. The work was undertaken in anticipation that it would be completed by May 1, but the inauguration of the experimental fumigation work at Vallejo and Davis extended this period into July and necessitated frequent trips back and forth from Utah to California to keep in touch with the progress of the work. However, it is believed that the examinations were made frequently enough and so distributed throughout the whole crop season, fruits excepted, that my findings represent the actual present conditions existing within the area in question.

LOCAL CONDITIONS.

The district under observation lies in Solano County immediately north of the Straits of Carquinez and extends from Vallejo to Benicia, a distance of about 8 miles east and west and for some 3 miles inland. The country is hilly and rises gradually inland and connects with the Coast Range to the north. The soil is mainly adobe, deep mud during the wet season, dry and hard during the summer. The winds here are mainly from the west, and during the period of observation this was the prevailing wind for a large part of the time. The present season has been remarkably wet, occasional rains continuing almost up to July, so that the crops rarely suffered from lack of moisture. These moist conditions are particularly favorable for injury by smelter smoke. Such smoke injury as is reported will therefore be representative of the worst conditions that are likely to

occur in the area. The annual crops grown consist almost wholly of small grains, barley, oats, and wheat. Various fruits are grown in small quantities. Stock raising is also one of the industries in the district. It is all open country, with scattered clumps and rows of eucalyptus, occasional orchards, and the usual California shade trees and flowers, with frequent cypress hedges.

More or less vegetation remains green throughout the winter, so it is possible to follow smoke injury readily throughout the year. As soon as the rains begin in the fall the native vegetation greens the hills in a few weeks and is rankest in March, April, and May, rapidly drying up with the advent of the dry season, so that for a large part of the year the country is brown and bare except where water can be obtained or perennial growth exists. Irrigation is not practiced in this district to any extent. With a few exceptions the orchards are not depended upon as a source of income and do not receive the care and cultivation necessary for success in the growing of fruits in California. In consequence they are now badly infested with insect pests and fungous disease. These causes, together with improper care and cultivation and the prevailing drought of the last three seasons, have produced general unhealthful conditions in the orchards of the area, conditions that have been attributed to "smoke" by the residents of the "smoke zone." This "unhealthful condition" is not confined to Solano County by any means.

BOTANICAL METHOD FOR DETERMINATION OF SMOKE INJURY.

It is only within the past few years that the branch of plant pathology that deals with smoke injury to vegetation has been sufficiently developed to make accurate diagnosis possible. A brief explanation of its general principles may serve to illustrate the methods here pursued.

The diagnosis of smoke injury is based upon the study of the condition of the lesions produced by the agents of injury; the markings, shrinkage, and coloration of the affected parts of the foliage; the general plant health; the microscopical examination of the injured tissues, particularly the cell shrinkage and the condition of the cell contents, and on certain microscopical reactions to determine the nature of these contents. Usually an examination of the foliar markings is all that is necessary to determine the presence of smoke injury.

As a rule there are only three kinds of injury to vegetation found in the vicinity of smelters which are produced by their emanations, as follows: (1) Flue-dust injury to plants, due to absorption of poisons from the soil through their roots (see Pl. XXXII); (2) acid-spot injury to

stems, foliage, and fruit caused by drops of sulphuric acid, usually condensed about small particles of flue dust, which are precipitated from the smoke stream (see Pl. XXXII); (3) sulphur dioxide injury to the foliage—rarely to stems or floral parts—due to absorption of the sulphur dioxide through the respiratory system of the plant or, more rarely, directly through the epidermal cells (see Pls. XV, XXII, XXIX to XXXII, XXXV, and XXXVI). The conditions for injury are more favorable in moist or damp weather. This is the usual form of injury about most smelters, and the only one now found in the Selby district, as is shown by the leaf markings that have been studied.

The different species of plant vary greatly as to their susceptibility to sulphur dioxide injury, and each has its peculiar markings and coloration, which in many cases are very similar to those produced by certain fungous diseases and insect injuries; so that in the selection of "guide plants," "Fang planzen,"[a] for the determination of smoke injury it is necessary to adopt those in which the smoke markings and coloration are most characteristically different from those produced by other agencies. It naturally follows that the smoke expert must be a plant pathologist, so as to be able to identify the common diseases and injuries encountered, which are liable to be, and, in fact, usually are, confused with those produced by sulphur dioxide.

Certain "guide plants," therefore, are selected. These should be plants most susceptible to smoke injury, species general over the region under investigation, in continuous foliage throughout the season, and those on which the smoke markings are most characteristic. In the "Selby smoke zone" it was found best to utilize for this purpose during the period of investigation the grains, the wild turnip, and the mustard, species not available after July 1. By means of these guide plants it is possible not only to determine the utmost limits of any smoke injury but also to make a fair estimate of the injury produced within any particular part of the area, as the relative amount of foliar injury corresponds in general with the diminution of crop yield. Many species of plants, however, appear to be able to suffer the loss of varying amounts of foliage without materially affecting the fruit yield, as, in a good season and with healthy plants, there is normally a considerable excess of foliage not necessary for the usual life functions.

In general it may be said of smoke injury produced by sulphur dioxide that it occurs on practically all the plants in a district that is materially injured—on some species more than others, and on a few, like the apricot and cypress, rarely ever. Therefore, in looking for smoke injury, suspicious markings on one or two species alone need hardly be considered, unless those species are known to be particularly susceptible to sulphur dioxide.

[a] Soraner, P., Jahresb. f. Agrikulturchemie, 1900, p. 456; Haselhoff and Lindau, Jahrg. 31, 1903, p. 120.

Injury to leaves by sulphur dioxide is evidenced, usually, in the form of intercostal spots and lines, and the principal veins normally stand out green in the dead areas, the coloration extending to the tips and margins with a more intense injury, though in a few cases the tip or marginal coloration is produced first. The color of the dead parts is usually white, yellow, brown, or red-brown, with intergradations, never black or pure red. It usually takes one to three days after injury for the color changes to be complete. The first injury is nearly always a faded yellow green, usually accompanied with wilting. There is never any actual "corrosion" or eating away of the tissue by sulphur dioxide, though in a few species, like the plum and chokecherry (*Prunus demissa*), the dead areas tend to shrink laterally and tear away from the green tissue adjacent, frequently forming holes in the leaves. Nor does sulphur dioxide ever in the smelter districts examined, and in the many experiments observed, have any effect upon the normal fertilization of the plants, except secondarily, through the foliage destroyed or, with intensest injury, in the actual killing of stems and flowers, an occurrence rare, except in the laboratory.

Two kinds of sulphur dioxide injury are generally recognized among smoke experts, particularly in Germany, where the subject has been most carefully studied:

1. Acute injury, sometimes termed "visible" injury from its pronounced markings, both on conifers and deciduous vegetation. (See Pl. XXXVI.) This is usually produced by single or repeated "visitations" of strong sulphur dioxide and is that most usual about smelters.

2. Chronic injury, sometimes referred to as "invisible" injury from its more indistinct markings. (See Pl. XXXVI.) This has been noted only on conifers, and more particularly in the lee of large manufacturing cities, where dilute sulphur dioxide is almost constant in the coal smoke arising from the manufacturing industries.

Strictly speaking there is no evidence of such a thing as "invisible" injury, that is, an injury affecting growth and yield, but yet not showing in the general health of the plant nor in foliar injury. The unfortunate term "unsichtbare Beschädigung" is employed by the Germans only as a synonym for "chronic injury" and is used to describe particularly the unhealthy condition of coniferous forests long subject to dilute sulphur dioxide influence, an injury that is certainly "visible." The term "chronic" or "invisible" injury has not, so far as I am aware, ever been applied by German investigators to deciduous trees and shrubs or herbaceous plants.

As a rule, the injury from smelter smoke is greatest in the path of the prevailing wind drift and occurs more frequently in damp weather. The "smoke zone" in some localities is confined to a small

angle in one direction from the industrial plant causing the injury; in others it is radiate, with the source of emanation at the center; in still others it is more or less circular or elliptical, the area being determined by prevailing winds and the land contours. Neither does the smoke "skip" certain areas and "drop down" upon another beyond to do material injury, unless a hill or forest be interposed, though with a high stack the injury is often less immediately adjacent. The smoke drift is always in straight lines with the wind, except as modified by land forms, and the injury normally diminishes directly with increase of distance from its source. A prevailing error in regard to smelter smoke is the supposition that the "bleached" vegetation is harmful to stock. It was once generally supposed in England that the vegetation injured by smelter smoke could be distinguished by its acid reaction,[a] but while this may be true possibly with wet foliage freshly injured, it appears certain that any such acid is fully neutralized and "fixed" by the plant in the process of injury and that the final condition of such bleached vegetation when dry is apparently not essentially different from that of uninjured plants after they have been cut and dried as "hay." Indeed, the "cooking smell," often mentioned as characteristic of crops freshly injured by sulphur dioxide, is that noted in fields of new mown hay of the same species and is merely the odor incident to drying. The bleached vegetation is not injurious to stock.[b]

INJURIES BY FUNGI AND INSECTS IN THE SMOKE ZONE.

The distinction of fungous diseases from sulphur dioxide injury is rarely difficult. Most plant diseases are well known and described in works on plant pathology. Leaves suspected of smoke injury and not sufficiently characterized by external markings and coloration may be sectioned and the tissues examined under the microscope. If the injury is caused by fungi, the characteristic fungous filaments will be found in or among the cells or on the surface of the leaf, or their fruiting spores can usually be seen. (See Pls. XXXIV and XXXVI.) If the disease is of bacterial origin, the bacteria will be found in the tissues. In case the injury is caused by sulphur dioxide these fungous hyphæ are normally absent, the cells are greatly contracted dorsiventrally, and the cell contents are homogeneous and arranged in plates or bands. This refers to sulphur dioxide lesions observed within a week or two after injury and after the color changes incident to the chemical reactions involved and the subsequent drying are complete. In time, under moist condi-

[a] Hamburger, S. Injury done to vegetation by gases arising from certain manufacturing processes: Jour. Soc. Chem. Ind., vol. 3, 1884, p. 202; abstracted in Jour. Am. Chem. Soc., vol. 6, 1884, p. 198.

[b] Widtsoe, J. A., The relation of smelter smoke to Utah agriculture: Utah Agr. Exp. Sta. Bull. 88, 1903, pp. 167-177; Merrill, L. A., ——, Western Chemist and Metallurgist, vol. 3, 1907, p. 59.

tions furnished by dew and rain, various saprophytic fungi, particularly *Cladosporium herbarum*, are apt to attack the foliage killed by sulphur dioxide, and these should not be mistaken for the cause of the injury.

Insect injuries to the foliage are even more easily characterized, as insects bite away the tissue externally or internally or puncture the cells to procure their food, and the insect itself, its eggs, or excreta, is usually found with the leaf to show the cause of the injury.

THE CYPRESS DISEASE.

The browning and death of the Monterey cypress, so general in all this district, is the most puzzling of all the abnormal conditions observed in the "smoke zone," and it is but natural that the residents should attribute the effects produced by this obscure malady to "smelter smoke."

In nearly all parts of the "smoke zone" of Solano County the Monterey cypress (*Cupressus macrocarpa* Hartw.) is now dying or dead, and the brown and dead branches and trees are found scattered among the living, in great contrast to the beauty of this species in most other parts of the State. This is most noticeable in and about the Vallejo cemetery, the Deming and Corcoran ranches, and parts of the district immediately north of Benicia, but it seems to be rare in the towns of Vallejo and Benicia themselves. Fully half the trees in the "smoke zone" are more or less affected.

In general, the affected trees are characterized by a gradual paling and browning of the green leafy twigs extending from below upward, the tips of the branches being the last to die. Small trees die solidly throughout, preceded by a general yellowing of the foliage; larger trees die in piecemeal, by separate branches, till the whole tree is dead. Often there is an accompanying rot of the lower bark and roots, while the affected trees seem to be always distinguished by a white flocculent deposit on the bark from a scale insect or by patches and streaks of exuded gum flowing from insect borings in the bark. This injury has now continued for several years and is clearly due to the gradual impairment of the vitality of the trees.

The problem was to determine whether this gradual impairment and death of the trees was due to smelter smoke, with the fungi and insects being incidental thereto, or whether the latter were the direct cause of the death of this important California shade species.

That the injury was in nowise due to smelter smoke appears from the difference in the character of injury. In injury to trees by sulphur dioxide, the tops of the trees and the tips of the branches usually die first, while short adventitious shoots appear toward the base of the branches and on the trunk—just the reverse of the injury here. Moreover, the Monterey cypress is one of the most resistant of species

to sulphur dioxide, and I can recall no case of material injury to this species by sulphur dioxide even in districts almost swept bare of other vegetation by smelter smoke. It is only necessary to instance the row of cypress trees on the bluff above Vallejo Junction, within a quarter of a mile of the Selby smelter, and frequently in the line of direct smoke drift, where nearly all other species show bad injury and even the resistant eucalyptus is dying or dead, and the cypress trees growing within a hundred yards of the smelter in the town of Selby itself. Also, conifer leaves and needles normally turn a bright red brown ("burnt sienna" color) when killed by sulphur dioxide, while the green leafy twigs of the cypress in this disease turn yellow and light brown on dying. Furthermore, the diseased condition is by no means confined to the district within which smelter injury is alleged, but extends northward at least to a point between Elmira and Dixon in the Sacramento Valley and southward to Sobrante, near Giant, in Contra Costa County, but the exact geographical limits where the disease occurs have not been determined. Neither is the injury always or mainly "on the side next the smelter," as careful observation has failed to show that any side of the tree is specially favored. Sections of the affected leaves and branches show no characteristic markings of any smoke injury under the microscope.

So far as I can determine there are several agents contributing to the production of this "cypress disease," but the time allowed for this investigation has not been sufficient to solve the problem completely. Examination shows that many of the trees still alive and most of those dead are affected by a wood-rot fungus (*Coniophora cerebella*, Schw.[a]), which attacks the roots, bark, and sapwood of the lower trunk and causes rapid decay, so that the trees are apt to blow over soon after death. This has caused the removal of most of these trees from the Vallejo cemetery. However, many of the trees found dying or dead seem to have no trace of this disease and the roots and wood are quite sound, as is shown in removing the trees from the cemetery, so that this can not be the efficient cause of the disease in most cases.

Sections of the dying leafy twigs in some cases have shown bacteria and fungous hyphæ in the cells and tissue, but these are not sufficiently abundant to play much part in the disease, nor are they always present in the dying twigs. They are usually found only in the dead tissue, as saprophytes. No other fungi, so far as I have observed, are commonly present or in sufficient abundance to cause the injury.

Many assign the death of the trees to the drought conditions that have prevailed in California for the three years previous to the present season. Some of the trees in the smoke zone are certainly dying from this cause, particularly those in the arsenal grounds east of

[a] Determination of Prof. Horne.

Benicia, and occasionally in dry situations elsewhere. Trees so dying resemble in many respects those dying from the disease, while the two though distinct, are commonly confused, and are not easily separated except by the presence of this wood-rot fungus or the insect pests hereafter mentioned. Also, it appears that the trees in the lowest places are apt to be first attacked, as seen on the Dos Reis ranch and in the grove at the bottom of Elliott Cove. It is also evident that if the disease were due to drought conditions, it would be found general over the State. This is certainly not the case. So far as I am aware, it has not been noted outside the district mentioned. Hence, though drought may aid the spread of the disease by reducing the power of resistance to these pests, it can hardly be the efficient factor. As a rule, where the cypress are found dying from drought, most other trees will be similarly affected.

All the cypress trees I have examined, not clearly dying from drought or other natural conditions but showing the general characteristics of this disease, appear to be infested by one or two insect pests, usually both in sufficient abundance to cause the unhealthy condition characteristic of the disease. In fact the "disease" appears to arise mainly from a combination of the work of these two insect pests. The one causing the most rapid destruction is a bark borer (*Phloeosinus cupressi* Hopk.[a]) which appears to attack perfectly healthy trees. If the tree is small, it dies rapidly. As a result of the girdling of the larvæ, streams of semiliquid gum exude from the holes in the bark and run down the trunk; the leaves of the whole tree turn first yellow, then brown as it dies. In large trees only the branches are thus attacked and the ravages of the insect are indicated by the scattered dead branches with more or less gum flowing from the wounds, while the bark, on removal, shows the tracings of the insect beneath. An instance of the first kind of injury is shown in the row of young trees on the north side of the Vallejo-Benicia road not far from the experiment station, as shown in Plate VI, and between this and the cemetery, where some 8 or 10 trees are dying from this cause. The row of trimmed cypress in front of the Carquinez cemetery shows the second kind of injury.

However, the most general and widely distributed injury, but where the death of the trees is very slow, unless aided by the first, is that due to a scale insect (*Sphaerococeus cupressi* Ehr.), which excretes a small amount of cottony tomentum, just sufficient to make its presence evident on the infested trees. This appears to cause a gradual decline in the vitality of the tree or branch and the gradual death of the foliage, the tips of the branches being last to die. In this condition the tree is readily attacked by the wood borers and

[a] Determination of Prof. R. W. Doane.

parasitic fungi, but may linger along for several years before death, unless these supervene.

It therefore appears that the "cypress disease" is caused by a combination of several injuring agents in the district in question and is probably not due wholly to any one, though the scale insect is the one most usually found. It is certain that the smelter smoke has nothing to do with the trouble.

THE SOOTY DEPOSIT ON PLANTS.

A common phenomenon throughout the smoke zone is a black, sooty deposit (fig. 14) on plants, more usually on the leaves, but often on the bark and even the fruit occasionally. This deposit is more frequently found "on the side next the smelter" in common opinion and so is naturally believed to be due to "smelter smoke." It is often massed densely on the under side of the thicker evergreen leaves, like the olive, and even occurs on grain, but without any actual injury being apparent. To the eye it strikingly resembles soot, but under the microscope it is found to be composed of black, closely adhering, angled or rounded cells with fungous filaments often extending outward from the masses and even penetrating the dead tissues of the leaf or bark (1 and 2, fig. 14), very different from the amorphous angular masses of soot (3, fig. 14), and clearly of fungous origin. This "sooty mold" (*Apiosporium salicinum* Kze., capinodium, and related forms) is common, not only in California, but all over the world, particularly near the sea where the air is damp, and it has no relation whatever to smelter smoke. It is strictly epiphytic, causing no disease, and its hyphæ rarely enter the live tissues of the host plant. It is called "Russtaupilze" or "Schwärze" by the Germans and "Fumagine" or "Noir" by the French, and the fungi are abundant wherever honey dew is excreted by aphis or scale insects, as in the case of the black scale of the olive. It is here mainly on the "side toward the smelter," because this is the direction from which the damp ocean winds blow. Further information can be had by consulting Stevens, F. L., The fungi which cause plant disease, 1913, pp. 191–195; Sorauer, Paul, Handbuch der Pflanzenkrankheiten, vol. 2, 1911, pp. 199–202; Prilleux, É. E., Malades des Plantes Agricoles, vol. 2, 1897, pp. 42–62.

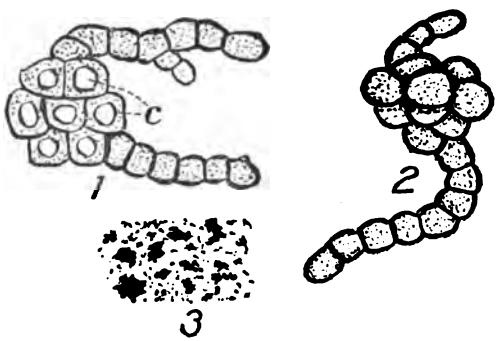

FIGURE 14.—"Sooty mold" and soot highly magnified. 1 and 2, sooty mold with some plant cells, *c*; 3, soot, similarly magnified.

THE BACTERIAL BLIGHT OF BARLEY.

This disease develops on barley, to a greater or less extent, wherever cultivated, but much less frequently on other grains and grasses. In appearance it wonderfully resembles forms of sulphur dioxide injury and only the microscope can distinguish it from that injury in its early stage, though the later browning is fairly characteristic. The blades of barley are "bleached" or yellowed in spots and streaks and often finely mottled like those injured by dilute sulphur dioxide, and these spots tend to enlarge and spread till the whole leaf may be killed. In later development, the "bleached" areas are bordered with a fine dark-brown line or streak next the green; or the smaller spots may show brown from the first. Sections of the spots under the microscope usually show abundant bacteria in many of the affected cells. The disease is caused by the presence of the symbionts *Pseudomomus avenae* Manns and *Bacillus avenae* Manns that appear to work together to produce the injury.[a] A curious fact regarding this disease is that it tends to develop on the injured parts of blades slightly damaged by dilute sulphur dioxide and can be distinguished externally from this injury only by the browning that later appears. Where this bacterial disease develops extensively, as it does occasionally on barley and oats, it is certain to be mistaken for smoke injury to these plants, if it occurs in the vicinity of a smelter. The disease is frequent and general in the district investigated, as well as in other parts of the United States not adjacent to any smelter or industrial plant.

THE HELMINTHOSPORIUM DISEASE OF BARLEY.

A frequent fungous disease on barley, oats, and some of the wild grasses in this district is the so-called "late barley blight," due to the fungus *Helminthosporium sativum*, Pammel, K. & B.,[b] which in the earlier stages of the disease strikingly resembles the mottling of sulphur dioxide and can be distinguished from it only by making sections of the injured leaves and noting under a microscope the fungous hyphae in the tissues, or the spores that usually develop after the death of the leaf. The disease not rarely becomes epidemic and does considerable damage to the grain, as was the case in one instance on the Dos Reis ranch. A very similar disease, *Helminthosporium gramineum* Ernk, in which the apparent "bleaching" is in long streaks on the leaves, instead of in spots, is also frequent in the fields examined and not rare on the wild barley grass and wild oat. These diseases and the bacterial blight, also common on barley,

[a] Stevens, F. L., Fungi which cause plant disease, 1913, pp. 22-24, 40; Manns, T. F., The blade blight of oats; Bull. 210, Ohio Agr. Exp. Sta., 1909, pp. 91-166.

[b] Pammel, L. H., King, C. M., and Bakke, A. L., Two barley blights, with comparison of species of Helminthosporium upon cereals: Iowa Agr. Exp. Sta. Bull. 116, 1910, p. 182.

render it unreliable as a "guide plant" in any region where smoke injury is suspected.

THE SHOT-HOLE DISEASE OF STONE FRUITS.

This disease, due mainly to the fungus *Coryneum Beyerinckii* Oud., is usually destructive in this whole district, and the holes in the leaves are frequently pointed out as "smoke injury" on the apricot, cherry, peach, almond, prune, plum, etc. In early spring the tips and margin of the young leaves, particularly of the almond, are browned and killed, but later the disease shows in the form of many small holes in the leaf, in the case of the peach usually accompanied with a bright red coloration and premature leaf fall. The popular impression that such holes are "smoke spots" that have been formed or been eaten out by the acid of the smoke has no foundation in fact, except in the case of thin-leaved plums where the dead tissue frequently does fall out and leave similar holes. In beets, radishes, cabbage, and turnips badly injured by sulphur dioxide the dead tissue frequently rips out or is torn away, but always with more or less tissue left in place to distinguish the injury. There is no smoke injury of this nature anywhere in this whole district. There is no question but that the leaves with holes in them are affected with this Australian shot-hole disease, or are eaten out by insects, just as they are in most other parts of the State. Sections of the dead tissue will often show the characteristic spores. In the case of garden vegetables like cabbage, turnip, radish, etc., with such holes, the cause is here found in the cabbage worm or the larvae of other biting insects, which will usually be found on the under side of the injured leaves.

OTHER FUNGOUS DISEASES.

WOOD-ROT FUNGI.

Wood-rot fungi of many species of Basidiomycetes enter the wood of trees through wounds or bark sunburn, and cause by their spread in the bark or wood the ultimate death of their host. These are usually recognized by the white felty filaments in the wood and bark and by the "toadstool" excrescences on the surface, forming the fruit of the fungus. The peach, almond, prune, apple, pear, cherry, cypress, eucalyptus, and most of the other trees generally grown for fruit or shade are subject to these wood-rot fungi. Trees dying from these causes are commonly referred to as "killed by smelter smoke," even when the fruiting bodies are plainly evident on the bark. In many cases it is only by cutting down the tree or digging about the roots that this rot can be shown to be the cause of the trouble.

PEAR BLIGHT.

Pear blight, affecting both the apple and pear, is now so generally known that its recognition should not be difficult, yet this is frequently pointed out as "smoke injury" by orchardists of the smoke zone, who have not yet learned to recognize the blackened twigs and fruit and the dead bark on trunk and branches, which are characteristics of this disease.[a]

GROWN GALL.

Grown gall also occurs to some extent on the roots of various trees, like the almond, apple, peach, and prune, and may seriously affect the health of the affected trees. In this case the cause may be obscure and may often be found only by digging away the earth from the roots.

GUMMOSIS.

Gummosis of the cherry, almond, and peach is also common here, and is frequently fatal, particularly to the cherry. The yellowed leaves and exuded gum on the trunk or branch indicate the trees affected.

LEAF CURL.

Leaf curl of the peach and almond occurs frequently, but the thickened, contorted leaves bear no resemblance to any form of smoke injury.

BLIGHT.

Blight on barley and certain wild grasses causes spots and lines on the leaves not readily distinguished from smoke injury by the eye, but under the microscope the hyphæ in the tissue and the spores of the fungus (*Helminthosporium*), described on page 390, can be recognized.

MILDEW.

Mildew (*Peronospora trifoliorum* De Bary) causes an apparent yellowing or "bleaching" of the leaves of clover and alfalfa, liable to be mistaken for smoke injury, but the fungus can usually be recognized as a felty mass on the underside of the leaf, even with a low-power hand lens.

A species of Macrosporium was found to be killing the tips of alfalfa in Benicia. It was pointed out as probable smoke injury by some of the residents.

DOCK DISEASE.

The dock disease common over this district is due to the fungus *Ovularia oblique* Sacc., which shows on the leaves of the common

[a] Smith, in 1909, reported this disease to be worse in Solano County than in any other part of the State: Smith, R. E., Report of the plant pathologist to July 1, 1906: Cal. Exp. Sta. Bull. 184, 1909, p. 229.

dock (*Rumex crispus* L.) as small round yellow spots with purple margins (see Pl. XXXIII). "Acid spots" on this species are brown.

HOLLYHOCK DISEASE.

The hollyhock disease (*Puccinia malvacearum* Mont.) spots the leaves of hollyhocks and of *Malva rotundifolia* generally throughout this district.

In the whole section under observation this spring it was observed that many of the lower leaves of the grain crops, particularly barley, yellowed prematurely, that is, became bright yellow throughout, even when the grain was not in a low situation. In the field where the fumigation experiments were carried on an abnormal yellowing of the lower leaves was noted. This coloring in other fields was unquestionably blamed to "smoke" by the farmers, yet sulphur dioxide had nothing to do with it. Later, as the blades died, the spores of *Cladosporium herbarum* Lk. abundantly developed on the dead leaves and it is probable that this fungus, usually a saprophyte, had here become parasitic during the remarkably wet season and caused the injury.

These are some of the common fungous diseases frequently mistaken for "smoke injury" in the Selby smoke zone.

INORGANIC INJURIES.

Inorganic injuries are much more difficult to recognize and to distinguish from sulphur dioxide injury than those classed as organic diseases. The tissue is neither punctured nor eaten away, nor does it contain the fungous hyphæ or spores. In some cases, like fire injury and sunscald, it is extremely difficult to find any certain means of distinction, even under the microscope. Fortunately there was little of this class of injury, while where it did occur the small area affected and the local conditions served to show its cause.

FLOODING.

Flooding was common in early spring and the grain under water later developed an unusual amount of yellow leaves. This abnormal yellowing of the foliage was sometimes attributed to smelter smoke by the residents of the "smoke zone." The uniformity of coloration and its occurrence only in low ground made it clear that the trouble was brought about by flooding.

DROUGHT.

Drought, on the contrary, was rare during the period of observation, but its effects, from the several dry seasons of the years immediately previous, on all kinds of trees in the district was plainly evident.

It was most pronounced in the arsenal grounds east of Benicia and on the higher hills over the whole district. In particular it developed a peculiar eucalyptus disease, always, here, pointed out for smoke injury. The leaves became white-mottled or brown on the tips and margins, and often intercostally, singularly like forms of sulphur dioxide injury, but unquestionably due to the drought conditions and the hot winds. The injury frequently showed in low ground, where the usual water supply had completely failed, and also appeared sometimes on dry rocky hills, like that on the road just north of Benicia. The same appearance was found on the eucalyptus at Palo Alto and in the north part of Berkeley, as well as in other parts of the State, to a greater or less extent, so that its cause can hardly be questioned.

Similarly, in the same situations, the tips of the pine needles turned brown, the margins of the leaves of the acacia died and the cypress browned and died, much as in the case of the "cypress disease" mentioned before. A similar dying of orchard trees was observed in a few instances, but where cultivation was practiced this was largely prevented. The same conditions prevailed elsewhere in the State with similar soil and situation, so that the smelter smoke was not concerned with this form of injury.

IMPROPER CARE.

Improper care, or rather lack of care, was frequently responsible for the condition of orchards, where smoke injury was alleged. A general lack of spraying, poor cultivation, frequent pasturage, improper soil for the several species, lack of drainage in some cases—all went to make up the unhealthful condition found and frequently ascribed to smelter smoke by the residents of the smoke zone.

FIRE.

Fire injury closely resembles that of sulphur dioxide and was found where prunings had been burned or grass fires prevailed. However, such injury showed only on the lower leaves and branches of the trees, instead of on the uppermost, as in smoke injury. It was usually more on one side of the tree and that often not "the side next the smelter."

FROST.

Frost injury was pointed out in a few cases as that due to "smoke," but the difference in coloration and markings is always distinctive.

Failure of fruit to "set" is always alleged in the smoke zone to be caused by the smelter smoke, but is clearly due to cold ocean winds, to rain at the time of blooming, or to "cold spells" or unusual hot winds after the fruit has set, causing it to fall off. This same trouble

is common in all parts of the State where similar climatic conditions prevail. Smoke does not normally in any way affect fertilization or cause the fruit to drop off, except in cases of very severe sulphur dioxide injury, where a large part of the foliage of the tree is killed and falls off, thus preventing the usual food supply. That smelter smoke will affect the fertilization of plants and the setting of fruit without other visible injury is a popular idea, but has no basis in fact. The smoke from the Selby smelter has not the slightest effect upon fruits or the yield of cereals in this district.

NATURAL CONDITIONS SOMETIMES MISTAKEN FOR SMOKE INJURY.

LEAF MATURITY.

Leaf maturity, the usual yellowing and death of the lower leaves of grain and grasses and the older leaves on trees, has been frequently pointed out as due to smoke, but it is necessary only to check up this condition in other districts far removed from any possibility of smoke contamination to see that there is nothing abnormal about it. The absence of the usual sulphur dioxide markings of the species shows that the smoke has nothing to do with the "injury."

In early spring the young foliage and shoots of the eucalyptus in the smoke zone naturally assume a peculiar brownish green and the same is often seen on young orchard trees, like apricot, which is pointed out as "caused by smelter smoke." This is a good instance of the lack of observation of some people who see these things, just as they do frost injury, all their lives, and yet notice them only when they are expecting something abnormal from the "smoke."

Another case called to my attention was a peculiar browning of certain cypress trees in spring, which was instanced as "smoke injury." Examination showed that the trees had only come into bloom, just as they had every year since the party had owned the place, and yet before went unnoticed.

Also vines exposed to the cold ocean wind do not bud as early as those on the sheltered or sunny side of buildings "away from the smoke," and this has been indicated on several occasions as caused by the smelter smoke.

SMOKE INJURY IN SOLANO COUNTY.

The northern shore of the Carquinez Straits is distant about 1 mile to the northeast of the smelter. Here along the shore, which is bordered with steep hills and an occasional indented "cove," careful watch has been kept for approximately six months to see whether any form of smoke injury could be found on the vegetation, while occasional trips were made farther inland for the same purpose. The

dates of these several examinations are January 9, 10, and 30; February 26; March 9, 12, 21, 24, 26, and 28; April 2 and 20; May 11 and 31; June 3, and July 1, covering the period when the usual crops are in the field, the rains most frequent, and the vegetation rankest and the period when smoke injury would be found if it occurred at all.

Inasmuch as the smoke drifting across the straits directly against these coastal hills would do more damage here than in any other part of the district, much less attention was given the section lying north of the Vallejo-Benicia road. However, the coast line itself, particularly that from Dead Mans Point to Glen Cove, was closely observed on most of the occasions mentioned. Frequent examinations were also made around Benicia.

At one point about halfway up the hills and about half a mile east of Dead Mans Point unquestionable minute traces of sulphur-dioxide injury were found on the young vegetation on two occasions—January 30 and February 28. This injury was found after rain and when the soil was still wet. The injury here was so slight that it would have gone unnoticed by the casual observer and in fact was not reported by any resident of the smoke zone. On March 24 and 28 a few sulphur-dioxide markings were observed on the weeds at station 1, near the "old mill" in Benicia, 4½ miles east in direct line from the smelter. Here again the injury was slight and inconspicuous and the smoke did not affect wheat or fruit trees near by. At one time, April 20, a field of barley of some 15 acres, on the hill to the northwest of Dos Reis Cove, showed strong yellow and brown mottling, remarkably like injury from dilute sulphur dioxide, which was at first mistaken for such. Later microscopic examination showed it to be a form of Helminthosporium bacterial blight, with the characteristic lesions of smoke injury absent. All other injuries to plants in the entire smoke zone were found to be due to agencies other than smelter smoke.

It is therefore possible to say with certainty that, except for the slight traces of sulphur-dioxide injury in the two localities mentioned, the smoke zone has been entirely free from any actual smoke injury to vegetation during the period of observation and that the fears of the farmers that the conditions in the smoke zone were due to smelter smoke are unwarranted. The conditions are due wholly to other agencies, mainly insect pests and fungous diseases.

As to the fact of past smoke injury to this district, it is not now possible to determine with certainty. However, a row of eucalyptus trees on the ridge to the east of Dos Reis Cove has been badly injured sometime in the past, apparently by fire, possibly by smoke coming from the west. Their tops are still in bad condition. The eucalyptus grove in the same cove and directly across the straits from the smelter

NATURAL INJURY BY SULPHUR DIOXIDE TO LEAVES.
1, Eucalyptus (rather old injury); 2, Turnip; 3, Nasturtium.

NATURAL INJURY TO LEAVES OF TREES BY SULPHUR DIOXIDE.
1, 2, Apple; 3, 4, Pear; 5, Plum.

NATURAL SULPHUR DIOXIDE INJURY TO LEAVES.
1, Grape; 2, Potato; 3, Rose; 4, Tomato.

NATURAL INJURY TO LEAVES BY SULPHUR DIOXIDE AND FLUE DUST, AND BY SPOT.
1, Asclepias Speciosa Torr.; 2, Helianthus Annus L.; 3, 4, Apple Tree Leaf;
5, Injury by SO_2 and H_2SO_4 to Plum Tree Leaf.

and much nearer shows nothing indicative of smelter-smoke injury, but considerable fire damage. The adjacent pasture lands here seem to be subject to late summer-grass fires. Another row of eucalyptus in Glen Cove also shows injury to the tops of the trees sometime in the past, which may have been caused by fire or smoke. The injury to these eucalyptus trees is not of recent date and appears to date back several years at least. The cypress trees in the Vallejo cemetery have certainly not at any time been injured by smelter smoke nor have the orchards and vineyards of the smoke zone ever been materially affected. The injuries causing their unhealthy condition or death are clearly from other and natural causes in all cases examined.

In all my trips through the smoke zone I have only once been able to distinguish the odor of sulphur dioxide, and then only for a few minutes and very faintly, at a point about 2½ miles northeast of the smelter. Sulphur dioxide to do material damage in dry weather to vegetation within half an hour must be so strong as to be almost unbearable, or if dilute must be very frequently repeated or almost constant over the area injured in order to affect vegetation at all.

THE OCCURRENCE OF SULPHUR DIOXIDE INJURY TO PLANTS IN THE SELBY SMOKE ZONE.

By Wyatt W. Jones.

INTRODUCTION.

The so-called "Selby smoke zone" consists of a strip of land along the bay or straits between the city limits of Vallejo and the eastern part of the city of Benicia and extending inland about 3½ miles to the northeast.

During the period of my investigation (from March 12 to May 8, 1914) no attempt was made to procure first-hand information as to the extent of the region involved, nor as to the nature of the allegations of the residents. In fact an effort was made to avoid conversations with farmers and others living in the region in order that the report might be based entirely upon actual conditions observed in the field.

Two to three visits to the region were made each week. Some time was spent about the Vallejo fumigation station and two days were consumed in traversing the road that forms the extreme northeastern boundary of the area, but the greater part of the time was spent in studying conditions on the farms along the Vallejo-Benicia road and between that road and the water front. Weather conditions were rather variable, and it was thus possible to observe the vegetation under variable atmospheric conditions with respect to humidity, temperature, and intensity of illumination.

My report deals with the occurrence of sulphur dioxide injury, the common fungous diseases, the presence of insect pests, the nature of the soil, the cultural methods and practices, etc. As the plant pathologist is concerned with all conditions that influence the health of plants, it was necessary to include this wide range of topics. Not only were the cultivated crops, trees, and ornamental plants observed, but also the native species, that is to say, the vegetation of the region was the subject of the studies.

Botanical specimens were taken on the various farms visited and along the roadways. Reproductions of photographs of certain of these specimens are shown herewith.

CONDITIONS ON PROPERTY OF WITNESSES NOS. 1 AND 1A.

The property of witnesses Nos. 1 and 1A comprises 1,150 acres lying partly in sections 19, 20, 29, 30, 31, and 32, or extending from the southeastern limits of Vallejo to a point approximately half way between Elliotts Cove and Dos Reis Cove, and from the water front to the Vallejo-Benicia road, No. 78.

This property is the largest and, for the present season or that part of the season included in the writer's investigations, by far the most important of those places over which the emanations from the Selby smelter pass, at least in so far as possible damage is concerned.

At the time of the first visit to the region, March 12, 1914, the limits of the property were not determined, and no examination of the crops was made other than an observation along the road above indicated. In front of the residence that stands opposite the property of Philip Steffan and in the northernmost part of the tract a small alfalfa plat was found to be in normal condition. Wheat and volunteer grain along the road farther eastward were very uneven, mostly considerably less than 6 inches in height, though more than a foot in spots. Barley and oat plants were scattered through this field, but no pathologic conditions were exhibited by any of the varieties.

On March 16 the grain had reached a height of 6 inches in general, though in spots it was as high as 18 inches, especially in the corner near the residence. A very careful examination was made of all the varieties of grain in this field and of the native vegetation for evidence of smelter smoke injury, but not the slightest suggestion of this condition could be found. Four or five blades of the tallest culms retained a good proportion of their green tissue. The lower blades were dead.

On April 7 the average height of the grain was about 12 inches in the corner nearest the residence. No pathologic conditions of importance were present. The grape vines about the residence were putting out a few shoots.

On April 11 a visit was made to the southermost part of the property or that adjacent to Dos Reis Cove. Behind the grove of eucalyptus trees in this cove very marked and unmistakable signs of smelter-smoke discoloration were found on native species, including broncho grass (*Bromus maximus* Desf.), soft brome (*Bromus hordeaceus* L.), common chickweed (*Stellaria media* Cyrill.), wind-mill pink (*Silene gallica* L.), poor man's weather glass (*Anagallis arvensis* L.), and burr clover (*Medicago denticulata* Willd.). The latter was slightly affected, whereas the Anagallis was prominently discolored. The discoloration of the brome grass was intermediate.

On the point of the hill north of the eucalyptus grove young barley 6 to 9 inches high was found to be noticeably affected by the smoke

from the smelter (see Pl. XXXV). However, one not in search of smoke markings would readily have passed without detecting any unusual condition. The markings consisted of fine spots commonly accompanied by a dark stain, identical with the markings produced in the fumigation tests. There was scarcely a blade that showed the usual bleaching resulting from smoke injury. Through this grain, blades of broncho grass were quite generally more than half bleached and even entirely bleached.

Along the border of the field wild-oat blades were prominently bleached and discolored, the bleaching often streaked in character. Here also the broncho grass was affected as in the open field. A luxuriant growth of black mustard in connection with the oat and grass blades was almost entirely unaffected. A few doubtful markings were noted.

On the steep slope above the water and facing the smelter other native species, including Eriogonum and lupine, were slightly affected. The lupine was also noticeably discolored by several species of leaf-mining insect larvæ (see Pl. XXXVI). The Eriogonum was badly damaged by a moth larva of the family to which the codling moth belongs. These conditions heightened the effect of the smoke injury and tended to give the impression of greater damage from the smoke than really existed.

April 15.—The barley plants mentioned above were found to have received no subsequent injury. The plants had made some growth and the injury previously noted was largely obliterated and would doubtless have been passed by the layman without notice. In the northern part of the property, which would be included in section 30—that is, adjoining the limits of Vallejo and near an old windmill—a field of young barley was carefully examined and found to be entirely free from smoke markings. The plants were 6 to 9 inches high. In certain areas the blades were yellowish from an excess of moisture in the soil. Numerous spots of brownish discolored tissue resulting from the growth of a fungus, Helminthosporium, were noted on the older blades. There were also numerous whitish markings caused by sucking insects. Barley that had already headed was found to be distinctly bleached from the hillside above the South Vallejo station to the southern limit of this variety. The bleaching was pronounced on affected blades, but only a small percentage of the blades was affected. It should be noted that this field of grain, extending southeastward from the limits of Vallejo, consisted of small patches of the three common varieties, oats, wheat, and barley interspersed. Passing southward from the South Vallejo station one encountered many of these plats of various ages and under different conditions. No discoloration was found on the oat blades and brome grass near the South Vallejo station, but approximately half way to

the south end of the field an occasional wild oat blade was found to be affected. The discoloration of the barley did not extend to the eastern edge of the field, but terminated perhaps half way across the area in an east and west direction. Broncho grass was discolored over the greater part of the area, but the markings were inconspicuous along the eastern border of the field.

May 2.—After the condition of the wheat on the property of witness No. 11 had been noted the wheat of this property near the residence was carefully examined and found to be somewhat thicker on the ground than the grain of witness No. 11. It was heading at an average height of approximately 3 feet. No indications of smelter-smoke injury were detected in this property along road No. 78.

May 4.—In the vicinity of the eucalyptus trees standing about the center of the place and along the road leading to the Dos Reis Cove a distinct oil odor was encountered. This odor was noticeable over a strip of land perhaps 20 rods wide. Farther south and beyond the mouth of the gulch that comes down through the grain field east of a small eucalyptus grove a distinct odor of sulphur dioxide was encountered, and was also noticeable over a stip of land a few rods wide. No evidence of injury to the grain was detected. Passing to the brow of the hill it was easily determined from the line of movement of the smoke that gas from the smelter was moving (or passing) to the point where the odor was detected.

A close examination of the barley was made to determine whether there had been any injury since the first discoloration had been noticed in the field. The plants were now over a foot in height and in what is called the "boot" stage. In only a few instances was discoloration found on the upper blades, and this was mainly in a small area on the northeast side of the knoll, about which this barley was growing. It was planned to revisit the spot in the near future to observe the effect of this fumigation.

May 8.—As indicated above, the area where the odor of gas was detected on May 4 was revisited and carefully examined for evidences of smoke injury. Not one blade of barley seemed to have been bleached or spotted. There were, however, evidences of an effect upon the wild-oat blades and broncho grass, both along the margin of the field and among the barley plants. Strongly bleached oat blades were found at the foot of the gulch above referred to, even beyond the northern edge of the tract of barley that had showed the smoke injury. A careful examination was made of a field of oats that immediately adjoins this barley on the north and west, and this was found to be entirely free from smoke markings. In making this observation the field was traversed from the border nearest the smelter to that farthest away. Next to this area on the west and north wheat was entirely free from discoloration. The wheat along

the road was well headed, but not beginning to ripen. In general, the stand was rather thin and the plants were uneven in height.

The pasture area was rather closely grazed before the 1st of May, and no distinct injury to native vegetation was observable more than a few rods from the bottom of the gulch through which a wagon road leads to the cove, and this was on leaves of filaree (*Erodium ciliatum* L' Her.).

The old orchard on this place seemed to have been neglected for a number of years and consisted mainly of almond trees. These were not examined, as they were not under cultivation, and apparently received no attention whatever.

The pear orchard, opposite the fumigation station—apparently a part of this property—was not really cultivated. The trees showed every evidence of neglect; many of them were stumps and others small clumps of brush resulting from the growth of suckers and water sprouts at the base of an older trunk which may have been broken off by stock. Blister mites were common on the foliage of these trees May 8. Several trees were rather well fruited. Barley had been sown in this orchard all around the trees. It was ripening on the last-named date, at a height of more than 3 feet. The heads were large and well filled.

Four or five head of stock were seen in the grain at various times, and in examining the field from one end to the other it was observed that these animals had a fairly well-beaten trail almost entirely around the area, and that they had tramped over and grazed over the entire area to some extent. The animals were young and perhaps permitted to take this advantage over the other stock kept on the more barren fields. Should complaints of low yield arise, this factor would be worth considering, though it was not an important element in the reduction of the yield.

The grain in general was uneven and "patchy"; weeds and native vegetation were abundant, especially several species of morning glory or bind weed (Convolvulus).

It should be noted that the fungus above mentioned, Helminthosporium, was common in all the barley plats and produced considerable spotting and discoloration, even hastening or causing the death of entire blades. Also that a rather large percentage of the blades showed a whitish discoloration or withering, in many instances due to a chlorotic condition associated with damp soil early in the season and a subsequent drying and cracking of the surface.

It will thus appear that the smoke injury that had been detected on this property was limited mainly to a small tract of barley in the extreme south end and to an occasional blade on the older barley in the western half of the grain field as far northwestward as the South

Vallejo station. Had there been plats of barley in the pasture land northeastward toward the property of witness No. 25 from the barley field that showed injury, it might have been possible to have traced the effect of the gas slightly farther in that direction.

To what extent the conditions of this season represent the average or normal conditions can not be determined, even from the statements of farmers. Wind records, etc., kept by others in the service of the commission, will supply this information.

CONDITIONS ON LAND OF WITNESS NO. 132.

The property belonging to witness No. 132 comprises 55 acres lying in section 32 or adjacent to Elliott Cove.

March 12, 1914.—In company with Dr. J. W. Blankinship I visited this place, noting especially the condition of native vegetation, shade trees, pines, roses, quinces, willows, and poplars. The pine trees showed a distinct yellowish discoloration, apparently due to water standing about the roots. The discoloration had no resemblance to smoke injury. The foliage of the eucalyptus trees was considerably spotted with white maculations which perhaps had been caused by fire about the base of the tree. However, this condition is commonly noted on eucalpytus trees in regions far removed from the possibility of smelter-smoke damage. It is brought on usually by winter changes or extreme and sudden summer heat. The latter cause is rarely operative, for the reason that this tree is resistant to drought and would not ordinarily be affected unless grown under conditions varying considerably from those of its natural habitat. Among the native species, wild roses, burr clover, and broncho grass (*Bromus maximus* Desf.) were carefully noted and found to be entirely free from smelter-smoke injury. The orchard adjoining the residence was observed to be in bad condition as to the shape and vitality of the trees. They were only partly in leaf at this time.

April 23, 1914.—On this date the property was visited in company with witness No. 11. The varieties above mentioned were found to be free from evidences of smelter-smoke injury, and it was also noted that the spring growth of the pines had obliterated their yellowish discoloration. The various varieties in the orchard were now in full leaf and found to have been considerably burned by the use of an improperly mixed spray. Apple leaves were falling freely and had brownish markings that might readily have been mistaken for smoke injury, and the same was true of the cherry leaves. In fact, the only foliage in this little orchard that was not so injured was that of a fig tree which the tenant stated had not been sprayed. He recognized the cause of this discoloration. The apple trees were badly infested with oyster-shell scale and green

aphis. The pear trees were considerably spotted by the spray and somewhat infested with the blister mite. A small amount of fruit had set on both apple and pear trees. The condition of the cherry trees was very poor; dead limbs were present; the trunks were gummy; the foliage showed marked burning by the spray; and the trees were ill-shapen and neglected.

Among these trees and extending somewhat beyond the limits of the small orchard barley had grown to a height of 2 feet or more since the former visit. The culms were heading and very badly infested with lice. The tenant had not noticed this, and when it was brought to his attention he stated that he had never seen anything like it before. There was also a distinct bleaching, particularly of the terminal and subterminal blades, caused by smelter smoke (Pl. XXXV). This condition was not sufficiently prominent to attract the attention of the tenant or of witness No. 11, both of whom walked through the field looking at the infestation of aphis. In many instances the blades were almost entirely bleached, the bleached blades being somewhat scattered about. The amount of damage, if any, was entirely inconsiderable, and it was evident from the condition of the lower blades that there had been no damaging visitation of smoke prior to the fumigation that had caused this bleaching, unless it had been when the grain was very young. Broncho grass (*Bromus maximus* Desf.) was slightly affected, but no other vegetation of any sort could be found that showed smoke injury. Younger barley on the low hill between the house of witness No. 132 and Elliott Cove proper was entirely free from smelter-smoke bleaching or spotting.

May 4, 1914.—Conditions mentioned as existing on April 23 as to insect pests, injury from spraying, etc., were still present. In reference to the bleaching of the barley blades there appeared to have been either a revisitation of the smoke or there had been no change in the blades previously bleached. The bleaching did not seem to be more extensive but occurred on the latest developed blades. Other susceptible vegetation, both native and cultivated, about the place was examined closely and found to be uninjured.

In this connection it may be mentioned that a few barley blades on the hill between Glen Cove and Elliott Cove in what was thought to be property of the Pacific States Trading Co., and also in the property of witness No. 49, adjoining Glen Cove, were found slightly bleached, apparently by smelter smoke. Only a few affected blades were found, and in such instances it is by no means certain that the discoloration was caused by smelter smoke, as it is possible to find, beyond the possibility of smoke injury, isolated specimens of various sorts of vegetation which can not readily be distinguished from specimens that have suffered smoke injury. However, broncho

grass, at the two points just mentioned, was affected similarly, which increases the probability of smoke injury. No other sorts of vegetation were found to be affected at these points.

The remaining tracts belonging to witness No. 132 were not examined and no reports can be made on the conditions that may have existed thereon. The main hayfield and also the barley above mentioned showed considerable spotting, due to the fungus Helminthosporium, but this is generally an unimportant factor in the reduction in yield of hay and grain. Some of the most thrifty and vigorous looking grain is often most seriously attacked by this fungus.

CONDITIONS IN THE VICINITY OF GLEN COVE.

Conditions in the vicinity of Glen Cove are described below.

March 12, 1914.—In company with Dr. J. W. Blankinship I drove down from the Carquinez cemetery to the place owned by witness No. 8, and noted that eucalyptus trees about the house showed pronounced whitish discoloration on both lower and upper leaves, such as is described elsewhere. Blackberries, acacias, willows, and a few garden varieties in the dooryard were found and noted to be free from smoke discoloration. The orchard of apples, apricots, peaches, plums, cherries, and almonds was not examined at this time. Only a few of the trees were in leaf.

Along the road the native vegetation, particularly that known to be most susceptible to smoke injury, was noted at various points and found to be in normal condition. Some distance down the gulch below the residence of witness No. 8 a field of barley, just up, was found in normal condition. The ownership of this barley was not determined. A strip of land in the bottom of the gulch was prepared for seeding but was still too wet to be sown.

Near a gateway at the top of the hill between Elliott Cove and Glen Cove wheat south of and oats on the north side of the road were examined and found to be entirely free from smoke markings, though the wheat showed noticeable yellowish discoloration of the lowermost blades. Barley plants in the oat field were also free from smoke markings. Fungous spots were present on both oat and barley blades. Between this point and Glen Cove native vegetation was examined and found in normal condition. In Glen Cove quite an assortment of plants, including trees, shrubbery, and herbage, showed no smoke markings. The herbage included a number of garden varieties that are particularly susceptible to smoke injury.

April 23, 1914.—The garden, shrubbery, and trees about the Glen Cove property were carefully examined and found to be free from smoke markings. Particular note was taken of a rather large bed of sunflowers near this garden, which were found to be green and

thrifty in appearance. The wheat on the land of the Pacific States Trading Co. showed more yellowish discoloration of the lower blades and a condition corresponding with that described as existing on the place of witness No. 11. The stand was quite thin and there were few culms per plant. At the top of the hill where the road passes through a gate to the Fish house, in Elliott Cove, barley and oat plants were carefully examined and found to be in normal condition save for the presence of fungous spots. Barley in the bottom of this gulch was a few inches in height, and though the ground was normally very moist from seepage, the area had been irrigated. Barley on the west slope of this gulch was in the boot stage and free from smoke injury.

May 4, 1914.—The various species of vegetation in Glen Cove which have been mentioned above were found to be free from evidences of smoke injury and other serious pathologic conditions in general.

A careful examination was made of the orchard of witness No. 5 and the following conditions noted: Almond trees were not especially thrifty; fruit was rather sparse; and black scales were present. Some of the leaves showed the presence of the shot-hole disease. The plum trees were in fair foliage, but somewhat infested with lice and badly infested with green, leaf-rolling, tortricid larvæ related to the codling moth worm. Fruit was quite abundant. Apricot trees were free from pathologic conditions and sparsely fruited. Apple trees showed a considerable infestation of oyster-shell scale. Woolly aphis was also noted. The pears were somewhat infested with blister mite, and some leaf rollers were present. In a garden adjoining beans, peas, beets, turnips, onions, and lettuce were found in normal condition. Wild oats and various sorts of grasses besides several species of shade trees were also in good condition.

On a hill between the two coves and also on the place of witness No. 49 a few barley blades were found showing discoloration that seemed to have been caused by smelter smoke. Considerable searching was required to find these blades. Helminthosporium spots were abundant in both places.

On the place of witness No. 8 an examination was made of the orchard and ornamental plants about the residence. Apples were found to be badly infested with woolly aphis, so much so that it was rather remarkable that the trees were living. A few of the trees were dead. The apricot trees were in fair condition. The peach trees showed many spots caused by the shot-hole disease. Lice were very abundant on the plums. The cherry trees were normal. One chestnut tree showed some burning of the foliage and cracking of the bark, presumably due to the location of the tree against the side of a building. Almond and pear trees were in fair condition, displaying no special pathologic conditions deserving mention. Acacias, wil-

lows, blackberries, roses, grapes, parsley, and grasses were noted and found to be in normal condition, save that the grapes were not growing rapidly. Barley on the hill east of the residence and wild oats, native grasses, etc., along the road were normal.

The barley field in Elliott Cove showed no smoke markings, nor were any markings of this sort to be found in the various species of grass and native vegetation.

CONDITIONS ON THE PLACE OF WITNESS NO. 11.

Conditions on the place of witness No. 11, comprising 469 acres lying in sections 28 and 33, are described below:

March 12, 1914.—This property was entered from the Glen Cove side and traversed to the outlet on the eastern side, but no careful examination was made of the various crops. The greater part of the area adjoining Glen Cove was not being cropped but had produced a rather abundant growth of wild oats, grasses, and weeds, and was being pastured by sheep. None of the species, either native or cultivated, in the area showed smoke markings. A plat of barley above the residence of witness No. 11 and near the cable anchor showed a pronounced yellowish streak in its central part, due to excessive moisture in the soil. The grain was much shorter in this strip than elsewhere. Witness No. 11 was cultivating the orchard, but we did not tarry to examine the trees as it was too early in the season to procure much data from orchard varieties and too late in the day to make an investigation. Between the residence and the main road we noted the condition of the pasture and of the wheat. The latter was thin on the ground and showed a slight yellowish discoloration of the lower blades. The pasture looked quite well. Various sorts of vegetation that normally show a susceptibility to smoke injury were examined along the road and found to be free from smoke markings.

March 18, 1914.—The northeastern extreme of the wheat field—that is, the part lying along the main road—was examined more carefully than on the former date and the plants were found to be 10 inches high. The blades were arching slightly and the stand was rather poor. Oat blades in the area were carefully examined and found to be in normal condition.

April 7, 1914.—Wheat at the point mentioned on the former date was somewhat over a foot in height; the upper blades were wide and showed good color. They were considerably arched but the lower blades were quite yellowish, and those on the middle zone of each culm showed a distinct mottling of fine yellowish spots, a condition that seems to be common to wheat throughout California at a certain stage of its development. The exact cause is not known to me nor to other pathologists with whom I have talked.

April 23, 1914.—As I was about to examine the orchard near the residence witness No. 11 alleged that there was nothing to be seen now in the orchard, that there was no smoke injury until later in the season when winds become more constant from the west; he requested me to drive back to the wheat field and note conditions. The wheat was then in the boot stage. Witness No. 11 complained of the thinness of the stand and the yellowish discoloration of the lower blades. He did not positively attribute these conditions to smelter-smoke injury but stated that there was some poison or other harmful substance in the soil which prevented the normal development of the crop. He stated that this had been well sown and that the land had not been cropped during the preceding three years. He further alleged that under such circumstances the plants should be so high and thrifty that it would be difficult to walk through the grain. He thought that he would not harvest as much as half a crop.

April 25, 1914.—In connection with allegations of witness No. 11 regarding his wheat, an average plant was taken on this date from the northern limits of the place and carefully described. The following notes indicate conditions: One culm, 56½ inches from the tip of its terminal blade to the ground. Terminal blade, 12 inches in length; subterminal, 15 inches long by three-quarters of an inch wide. The next blade lower was 12¾ inches long, the next 9½, and the next 8 inches. The last one was somewhat yellowish, though it still had considerable healthy tissue. The upper blades were arched and showed good color. A second culm was 16 inches from the tip of its terminal blade to the ground; a third culm was 13½ inches in length; four other culms were weak and with much dead tissue, and one culm was entirely dead. I did not at the time know the cause of the preeminence of the one culm and the dwarfing of the others in this particular plant, and consequently the thinness of the stand, but fancied that the explanation was associated with climatic conditions and the conditions of the soil that prevailed earlier in the season. Witness No. 11 was advised that the wheat had been carefully observed since the 12th of March, but that back of that time I had no information as to what conditions may have existed in this field. The specimen was subsequently studied in the laboratory and was found to be badly infested with Hessian fly.

May 2, 1914.—The wheat was heading at a height of 2 to 5 feet. The tallest blades were usually higher on the slope and the shorter ones on the lower areas. Witness inquired as to my further movements, and upon learning that I was going toward Glen Cove suggested that he accompany me. It thus happened that his orchard was not examined on that date.

May 4, 1914.—In the orchard I noted that four or five peach trees were dead and that others in little better condition were badly affected with shot-hole disease. The soil was in poor condition and in a poor state of cultivation. One apple tree showed a pronounced discoloration which suggested that a fire had been kindled too near the tree. No evidence of such a fire could be found to explain the phenomenon. Witness returned from Benicia before the examination was completed and stated that he did not know what was the matter with the apple tree, but that it could not be suffering from smelter smoke, else other trees would be affected similarly. The two trees adjoining showed slight discoloration. These trees were badly infested with green aphis and considerably infested with leaf-rolling larvae related to the codling moth. The pear trees were badly infested with blister mite and with the same kind of leaf-rolling larvae found in the apple trees. Most of the trees were small. Some fruit had set. The larger trees had a fair crop of fruit. The apricot and cherry trees were in normal condition save that there was little fruit present. The plum trees were badly infested with aphis. A few other insects were noted, but these were doing no considerable damage.

CONDITIONS ON THE PLACE OF WITNESS NO. 32.

Conditions on the place of witness No. 32, comprising 58.42 acres, lying in section 28, were investigated, with the results presented below:

March 12, 1914.—Barley in a field immediately adjoining the residence and north of the same was beginning to head at a height of 14 to 16 inches. Just north of this area a second small field of barley was only a few inches in height. About the residence a considerable variety of ornamental plants, date palms, roses, pomegranates, oranges, periwinkle, etc., were observed. The pomegranates had not yet developed the season's leaves and the orange trees were in bad condition, suggestive of neglect and drought. Peas just south of these ornamentals were beginning to flower and appeared normal and healthy. Still farther south, in a swampy area, some old fruit trees, especially pears, were observed and appeared to be in poor condition. On the knoll farther to the south an old orchard of plum trees with an almond border showed the same neglect and lack of cultivation. The almond trees were rather well covered with foliage, but had not been pruned for many years and were bushy, besides displaying a great many dead twigs. No indications of smelter-smoke injury were detected on this property.

March 16, 1914.—The young field of barley referred to on the former date was 6 to 8 inches high and less uniform throughout

than when first noted. No discoloration of any sort was noted save some blade spots caused by Helminthosporium. Pear and plum trees were in bloom. Native species of various sorts showed no smoke markings.

April 7, 1914.—The northernmost barley field was 12 to 18 inches high and coming into the boot stage. The plants were not so nearly uniform in height as formerly, but more even than in many other places. No mottling or discoloring was noted save a few of the fungous spots above mentioned. The older field of barley just south of this showed more discoloration by the fungus and showed an occasional blade mottled as described in report on the place of witness No. 12. The culms were 3 to 3½ feet in height.

April 23, 1914.—The northernmost barley field was now heading. The plat just south of this was beginning to mature. No evidence of smoke injury was detected on any of the native or cultivated species.

April 25, 1914.—Back of the residence a rather large garden, which was seemingly attended by Italians, was carefully examined and the following conditions noted: Potatoes were several inches high, but very uneven, some of the plants coming barely above the ground, and there were many vacant spaces. There was some slight discoloration of the leaves, produced by natural agencies such as insects, fungus diseases, and climatic conditions. This discoloration was insufficient, however, to attract attention. Corn was only a few inches high and in medium to poor condition; that is, the plants were not thrifty. Beans showed considerable yellowish tissue and were in a chlorotic condition. The beets were normal though rather small for the apparent age of the plants. The horse beans were tall and flowering but with considerable dark-brown discoloration of the foliage, particularly of the lower leaves, possibly due to fungous disease. All the horse beans noted in the region showed this condition. Carrots, cabbage, onions, and turnips were in fair condition with no discoloration. Lettuce showed a considerable wilting and discoloring due to the fungus Botrytis. The leaves and the bark of the plum and the prune trees were literally coated with prune aphis. Apples, almonds, figs, walnuts, and ornamentals were in normal condition save that they were uncared for, and the almonds displayed considerable dead wood. The figs showed some deforming of the leaves, and there were scale insects present on the apples and almonds. The peach trees were in poor condition, displaying what is known as "die-back," perhaps due more to neglect than to any other cause.

May 2, 1914.—The barley just north of the house lot was cut. The northernmost field was beginning to ripen. There was no evidence of smelter-smoke injury on the native or cultivated species.

Shade trees on the swampy area and adjacent thereto were in fine foliage.

CONDITIONS ON THE PLACE OF WITNESS NO. 12.

Conditions on the place of witness No. 12, comprising 779.16 acres, lying mainly in sections 22 and 27, were as outlined below:

At the time of the first visit to this property, March 12, 1914, in company with Dr. J. W. Blankenship, it was noted that the barley southwest of the road near the city limits of Benicia was in the boot stage. The plants were very uneven and generally thin on the ground. No discoloration of the blades was present save some spotting caused by the fungus Helminthosporium and the normal weathering of the oldest blades, which at this time were close to or in contact with the ground. The part of the field farthest southeastward was in the poorest condition. Farther up the road northwestward the plants were larger and the stand was generally better. On the hillside east of the road and immediately adjoining the city limits of Benicia, the barley was found to be very much taller and more thrifty close to the fence than a few feet away from the fence. The stand was also very much better and the color of the plants was more normal. In addition to the barley there was a considerable growth of wild oats, grass, and native vegetation close to the fence. This condition, that is, the narrow strip of thrifty grain along the fence, is quite common in the region, particularly on hill slopes, as the contour of the country necessitates plowing "round and round," thus piling up along the fence a stratum of surface soil more rich in humus than the soil in the open field. To be sure, there is also a washing from the higher levels and a consequent denuding and impoverishing of the higher lying soil to the advantage of the strip at the border of the field or along the fence where a slight embankment is formed by the method of plowing above cited.

In this connection it is well to note that while the less thrifty-looking grain is pointed out by farmers as evidence of smelter-smoke injury, the condition just described seems to indicate very definitely that the less thrifty grain has not been injured either by poison in the soil (a common belief among the farmers) or by atmospheric agencies, but its condition is due to the repeated cropping of the land to grain varieties, and probably also to the leaching or washing of the soil by rainfall. If poison were present in the surface soil, as imagined by the farmers, it would be accumulated at the base of the field and its effects there should be more noticeable than where the thinner stratum lies. No such strip of thrifty grain is observable on the upper levels, at least there is much less contrast between the grain of the upper border and that of the main part of the field.

On the slope of the hill near the city limits of Benicia barley blades were found to show whitish discoloration commonly somewhat mot-

tled in character and occurring on one blade, usually the second, third, or fourth blade from the last developed; more frequently than otherwise on the third blade from the terminal. This had somewhat the appearance of smoke injury, but was not typical or characteristic. A similar condition has been noted in another smoke zone under certain combinations of weather, soil, and stage of maturity. If it is due to smoke injury, it is not the generally-recognized type. It must be added that quite similar effects were produced during the summer by Mr. Wells in the fumigation tests. The amount of discoloration was generally small and unimportant. Many of the plants were entirely free from discoloration, and usually the affected plants retained a good proportion of green tissue. Farther northwestward along the slope a large tract seemed to have been spring-plowed, but not sown, as the grain plants were few and backward in development. Back of this strip the hillside was devoted to the production of wild-oat hay. It is probable that both the wild-oat hay and the barley above described were purely volunteer; that no seed was sown after the harvesting of last season's crops. Under these conditions clay soil becomes hard and baked at the surface, does not readily permit the penetration of rainwater, but may become very soft at the surface, even to the extent of "running together." Grain roots in such soil are often shallow and easily injured by the cracking and drying out of the surface layer.

About the residence of witness No. 13 eucalyptus and cypress trees showed discoloration. The cypress trees were apparently suffering from conditions that prevailed last season and even the season preceding, to judge from other known facts relative to this species and its occurrence in the bay region. The eucalyptus trees showed the same whitish markings described as occurring on the place of witness No. 132.

About the residence of witness No. 12 a small orchard of almond, apple, peach, apricot, and cherry trees had been cultivated and seemed in good condition. The almond trees were fairly well clothed with foliage and blossoms were appearing on the peach and apricot varieties. Garden peas had grown to a height of several inches and were in normal condition. The barley just northwest of this residence was in much the same condition as that farther east, save that it did not show the whitish discoloration. Native species, including burr clover, buckthorn (Amsinckia), Napa thistle, black mustard, and chickweeds (*Stellaria media* Cyrill. and *Cerastium viscosum* L.), wild oats, and native grasses, both in the hayfield and along the border, showed no discoloration resembling smoke injury.

March 16, 1914.—The barley in the main field, where discoloration was noted on the 12th, was at this time about a foot in height and had developed the last blade, though this was not fully expanded in all cases. Whitish mottling was still noted on the third blade from

the last. It should have been noted earlier that the barley on the slope where discoloration was noted was considerably higher and better in appearance than the barley growing southwest or west of the road, where no discoloration was found. Wild oats and a rather large list of native species, including those mentioned above and a few other varieties, were still free from smelter-smoke discoloration. The lower blades of the wild-oat plants along the margin of this field showed considerable brownish or reddish discoloration, due to age and weathering, and the younger blades were very commonly marked with purplish spots produced by Helminthosporium. Heads were beginning to appear on the west side of the road farther from the Benicia city limits, though the culms were still rather short. No whitish markings were found anywhere in this plat west of the road. Peas mentioned in the former report were in bloom and free from abnormal conditions. The peach and apricot trees were beginning to unfold their leaves and were quite showy with blossoms. The hayfield of wild oats showed no discoloration save that described in connection with the taller plants along the margin of the field. Wheat plants scattered about the fields on the east side of the road showed more or less yellowish discoloration, not in anywise resembling smoke injury. The barley plants showed considerable more discoloration, particularly of the lower leaves, caused by Helminthosporium.

April 7, 1914.—The whitish mottling of the barley blades formerly noted was still present and in about the same abundance. More discoloration had resulted from the fungus Helminthosporium, and the grain was heading.

Conditions were much the same west of the road as noted formerly, save that the grain was more advanced and there was more yellowish discoloration of the lower blades. The plat of barley in the western extreme of this place, adjoining the tract owned by witness No. 95, was 14 inches in height and fairly thrifty in appearance.

April 23, 1914.—The barley, west of the road in particular, was beginning to ripen. All of the blades showed more or less yellowish discoloration. The height was fair for volunteer grain, and the heads were medium to small. The heads were larger on the higher land and smaller on the lower land. The orchard and peas about the residence of witness No. 12 were in fine condition.

April 25, 1914.—There were no appreciable changes in conditions since the former report.

May 2, 1914.—The large field of wild-oat hay on the hillside east of the road was mostly cut and raked. The barley west of the road was ripening. Native species showed no evidence of smoke injury though many varieties had begun to dry from drought and maturity, especially burr clover and filaree.

May 4, 1914.—Conditions were unchanged except for the normal maturing and advancing of the varieties that were still growing, both of the cultivated and native species.

May 8, 1914.—Barley east of the road was sufficiently ripe to be cut for hay; that west of the road was already partly mowed.

CONDITIONS ON THE PROPERTIES OF OTHER PERSONS.

Conditions were also observed on the properties of the following: Witness No. 25, 135.43 acres; witness No. 4, 220 acres; witness No. 33, 50 acres; witness No. 34, 447 acres; and witness No. 95, 3.56 acres.

March 12, 1914.—Volunteer grain and native vegetation on the place of witness No. 33 were observed along the road. The grain was rather short, though considerably higher at the margin of the field than elsewhere. Otherwise the vegetation was in normal condition.

On the place of witness No. 25 an old orchard of pear trees with barley sown between the rows was noted. The barley was higher than any other in the region. The pear trees were beginning to flower. No discoloration was found resembling smoke injury.

Barley north of the road was somewhat higher than that in the orchard and considerably infected with Helminthosporium. A luxuriant growth of filaree, mustard, chickweed, burr clover, red maids, and other native species adjoining this plat of barley was found to be in normal condition. About the residence lemon, orange, and loquat trees were in normal condition save that the foliage of the citrous varieties was somewhat thin.

Two or three trees in a cypress hedge showed some discoloration. These trees were apparently dying, either from root troubles or from previous climatic conditions. Volunteer grain farther eastward was rather short, but showed no special conditions deserving of mention. A large area south of the road was not under cultivation, apparently intended for pasturage.

On the property of witness No. 34 an abandoned orchard of several of the common varieties was found to be half dead. It had apparently been browsed by stock. No evidence of smoke injury was to be found on the native vegetation on this place.

Opposite the place of witness No. 34 in the cemetery a large number of cypress trees had died and others were in very poor condition. The cause of this was not apparent and the reason can only be suggested in view of the poor condition of shade trees throughout the region caused by previous dry seasons. It seemed also that the soil at this point was rather shallow, being closely underlain by rock.

On the property of witness No. 4 volunteer grain occupied the narrow strip of land north of the road. This was rather short and thin on the ground. Some volunteer grain south of the road was in much

the same condition. About the residence ornamental trees and a few old fruit trees showed no pathologic conditions, excepting those resulting from neglect.

On the place of witness No. 95 barley and alfalfa plants besides native species were noted. The barley was somewhat less than a foot in height and showed a rather serious infection of Helminthosporium. The stand was quite uniform. Acacias were in normal condition.

March 16, 1914.—On the place of witness No. 33 volunteer grain was measured and found to be not over 6 inches in height, though 14 inches along the fence. The height of the plants was somewhat variable in the open field. No pathologic conditions save the presence of fungous spots and thrips markings were present.

On the place of witness No. 25 barley north of the road was 1 to 3 feet high and showed no discoloration except of the blades at the base of the plants. An occasional blade was found which showed the white mottling described in the report on the place of witness No. 12. This blade was usually the fourth from the last developed. Helminthosporium was especially abundant. Some mildew was noted on the wild oats, and thrips markings were rather common. The native species referred to on the former date were in normal condition. Barley south of the road varied considerably in height, from 1 to 3 feet. Volunteer grain in the eastern portion of the place was somewhat better than on the place of witness No. 33.

On the property of witness No. 4 it was noted that stock had been grazing the volunteer grain north of the road. The plants were mainly barley near the barn and mainly wild oats farther up the hill. Mustard was very abundant in the barley. The old orchard trees back of the residence were in leaf. No examination was made. Burr clover, filaree, chickweed, etc., were found to be free from smoke markings.

Barley on the place of witness No. 95 was found to be about 8 inches tall. Some of the plants were small and weak and the blades showed a streaking suggestive of a bacterial disease, but caused by the fungus *Helminthosporium graminum.* Another species of Helminthosporium was abundant.

March 18, 1914.—Conditions on the places named on the 16th were much the same, except that vegetation was slightly more advanced.

April 7, 1914.—Volunteer grain on the place of witness No. 33 was now about 12 inches in height. No important pathologic conditions were noted.

On the place of witness No. 25 barley north of the road was badly infected with Helminthosporium. Many dead blades were

noted near the base of the culms, and these were commonly marked by spots of saprophytic fungi. The pear trces were past the blossom stage and fruit was setting. A small plat of barley had been cut for green feed.

Volunteer grain both north and south of the road in the western part of the place of witness No. 4 was heading at a height of about a foot. The barley north of the road near the barn was considerably grazed and mustard plants were very prominent. Thrips markings were especially abundant on the wild oats.

On the place of witness No. 95 barley was 14 inches or more in height and in the boot stage. The conditions mentioned on the preceding date were still present and in about the same degree. During the remainder of the investigation these places were noted at rather frequent intervals and at no time was smoke injury found on any sort of vegetation along the road to the fumigation station from Benecia. The main pathologic condition that was later noted was the almost total defoliation of five or six pear trees in the orchard of witness No. 25 by the greenish, tortricid, leaf-rolling larvæ mentioned in connection with the orchard of witness No. 5. This condition was observed on the 11th of April. In May these worms were found pupating.

May 2, 1914.—The barley in the orchard of witness No. 25 was cut and being raked. One blade in a strip which had been missed by the mower showed markings which closely resembled smoke injury.

Oats on the property of witness No. 4, south of the old orchard, were found to show considerable yellowish and reddish discoloration of the blades. The plants were rather short and not as thrifty as they should have been at that season of the year. The sowing had doubtless been done late. Wheat in the extreme western part of this place and north of the road was heading at a height of about 2 feet.

CONDITIONS IN THE WESTERN PART OF BENICIA.

The westernmost part of the limits of Benicia consisted of barley fields, a large part of which was said to belong to the Montgomery estate.

On March 12, 1914, this barley was in essentially the same condition as that on the place of witness No. 12 immediately adjoining. The mottled discoloration of the blades was identically the same and quite generally distributed over the hilly area. Near the city limits a small garden and house lot were observed from the road. The almond trees over the fence showed a discoloration of the foliage generally characterized by straight lines and bands which had no resemblance to smoke injury. These trees were doubtless subjected to a considerable variation in the water supply, and the discoloration

may well have been due to that factor. Bramble foliage was carefully noted and found to be free from smoke markings. Grass and native species showed no injury.

Somewhat farther from the city limits a field of volunteer grain was examined and found to be entirely free from evidences of smoke injury. This field was directly opposite the new residence owned by witness No. 67. Slightly farther eastward a field of barley was noted and seemed to be in normal condition. Still farther eastward a field of wild-oat hay on the north side of the road, belonging to witness No. 76, whose residence is on K Street, was in fine condition, save that the blades showed fungous spotting and a considerable infection of mildew. The lower blades were often yellowish or entirely dead from age and weathering. Along the road a luxuriant growth of black mustard and burr clover was found to be free from smoke markings.

A large garden lying some distance up a gulch from the road was closely examined and found to be in good condition, free from smoke markings and other pathologic conditions, save a dark-brown discoloration of the leaves of the horse beans, as cited elsewhere.

March 16, 1914.—The volunteer oats on the lot of witness No. 76 were heading. From two to four blades only were entirely green. The plants were thick on the ground and the lower blades were commonly brownish or yellowish. Some whitish marginal discoloration was noted on subterminal blades. Helminthosporium spots were numerous and thrips were found producing a characteristic spotting of the blades. Black mustard, burr clover, filaree, gum plants, and other native species showed no evidence of smoke injury.

On the Montgomery estate it was noted that the barley northeast of the road was very uneven, being from 1 to 3 feet in height. The subterminal blade was expanded or unfolding on most of the culms. The whitish mottling referred to above was still in evidence. A few wild-oat plants in the barley showed a marginal whitish discoloration not typical of or closely resembling smoke injury. Chickweed and other native species were in normal condition.

The volunteer grain opposite the residence of witness No. 121 was being pastured. Four blades were green, though the subterminal ones showed some brownish streaking or spotting. Burr clover, both gray (wild rutabaga) and black mustard, chickweed, Napa thistle, morning-glory, filaree, fennel, and the native grasses showed no discoloration.

March 23, 1914.—About station 1 filaree showed a very brownish discoloration which was apparently caused by smelter smoke. Burr clover was entirely unaffected. Mallow, in addition to the normal discoloration and injury produced by rust, showed characteristic smoke markings and broncho grass (*Bromus maximus* Desf.) was slightly

affected. It was rather unreasonable to suppose that this condition was caused by a visitation of smelter smoke, since burr clover and other very sensitive plants were unaffected. Nevertheless there are a number of inexplicable matters in connection with smoke investigations which would lead one to overlook these apparently contradictory conditions. Wheat immediately adjoining the area on which these discolored species grew was in normal condition.

March 30, 1914.—Just eastward across the gulch from station 1 a plat of wild oats was carefully examined and found to be in good condition. The plants were tall and thrifty and showed no evidence whatever of smoke injury, except that the fourth blade from the last developed was somewhat bleached at the end. This bleaching was, however, so old and so greatly influenced by weather conditions that it was impossible to determine what had been the original cause.

April 7, 1914.—The whitish mottling of the barley blades on the Montgomery estate was still conspicuous and affecting the second and third blades from the last developed. Smut was abundant in the heads. No evidence of smoke injury was found on any of the places cited above, save that conditions about station 1 were only slightly changed by a subsequent growth of the species involved.

April 11, 1914.—Witness No. 133, who resides in the western part of Benicia adjoining witness No. 76, complained bitterly of the "total destruction" of the peach orchard and other crops on his small lot which lies between the road and the water front. An examination was made of the property and it was found that the most sensitive species were apparently in normal condition and entirely free from smoke markings. Apricots—among the most resistant species to smelter fumes—were in bad condition, apparently from a root trouble or sour sap. The trees in question were merely seedlings and small. Fig trees were found to be losing their fruit freely and to show a peculiar deforming of the foliage, both of which witness No. 133 considered due to smelter injury. The cause of this was not determined. Peach trees were densely covered with black aphis. Apple trees showed no discoloration. Lettuce, roses, and a large list of ornamentals were carefully examined and found to be free from smoke markings.

Various other points in the western part of Benicia were visited and all sorts of vegetation examined, but no smoke injury was detected.

April 23, 1914.—Opposite the residence of witness No. 121 in the western part of Benicia barley plants were 14 to 18 inches high and in the boot stage. The lower blades were generally yellow or dead. The soil, which was heavy clay, was badly cracked and drying out.

On the Montgomery estate barley was ripening and the blades were practically all yellowish.

An examination was made of a garden on the lot on K Street of witness No. 76 and the following conditions noted: Beans, beets, peas, lettuce, cauliflower, carrots, corn, pears, and peaches were all in normal condition. The potato vines were rather uneven and the leaves showed some brownish spotting. The lettuce was mature and many of the plants were apparently infected with Botrytis. The oat plat was half cut and a liberal quantity of hay was being harvested.

April 25, 1914.—A careful examination was made of a garden near the western limits of Benicia and the following conditions noted: Peas, beans, beets (both red and white), lettuce, carrots, squash, blackberries, almonds, lambs' quarter, broncho grass, dock, and certain other native species were found to be free from smoke markings. Some leaf-hopper injury was noted on squash leaves. The almond trees showed the discoloration above described. A woman residing on this lot complained considerably of smoke injury and of an "unbearable odor which was frequently present." When asked to indicate what varieties in the garden were affected she replied that nothing seemed to grow as it should.

The oat plants on the lot of witness No. 134 were examined and found to be free from smoke markings. The plants had grown to a considerable height and were in every way thrifty. Native vegetation was found to be in normal condition.

May 2, 1914.—The oat plants on the lot of witness No. 134 on J Street were beginning to ripen at a height of 5 or 6 feet.

About station 1 wheat and grass were in normal condition, though the wheat showed an abundance of yellowish discoloration, particularly the lower blades.

Potato leaves on the lot of witness No. 76 showed considerable brownish spotting and the vines were rather small. Witness complained that the potatoes were "knocked out" as soon as the wind began to come from the direction of Selby. The ground was very dry and the potatoes were being dug. Barley opposite the residence of witness No. 121 was beginning to head. Wild-oat plants were rather short and with a considerable yellowish discoloration of the lower blades.

No smoke injury was detected within the city limits.

As the lot of witness No. 134 on J Street, just across the gulch from station 1, seemed in the line of frequent winds from the Selby smelter, and as these plants had, earlier in the season, shown a whitish discoloration of the blade ends, it was thought desirable to take some of these plants and describe them accurately. The following description pertains to one of the larger plants, but a specimen which was little above the average: Height from ground to end of longest blade, 5½ feet; length of terminal blade, 16½ inches; subterminal blade, 21½

inches; next lower, 19½ inches; next lower, 17¾ inches; next lower, 16 inches; width of terminal blade, 1⅜ inches. The terminal and subterminal blades were all green save for a slight marring at the ends. The next blade was about half green—not a bright green. The next blade was considerably more yellow, the next one quite yellow, and all below this were dead. The head was entirely green, and the number of double grains was 150. These measurements are given to show that wild oats, though very sensitive to smelter fumes, growing at a point where sulphur dioxide from the smelter was probably carried frequently, grew to rather unusual or abnormal height, and were thus apparently unaffected by the strength of sulphur dioxide that reached the point.

CONDITIONS ALONG THE ROAD LEADING NORTHEAST FROM BENICIA.

Conditions along the road leading from Benicia northeast to Vallejo were as follows:

March 12, 1914.—In company with Dr. J. W. Blankinship I made a trip along this road to skirt, so to speak, the limit of alleged smoke damage from the Selby smelter.

East of Benicia, on the arsenal grounds, cypress, eucalyptus, pines, and even pepper trees showed considerable discoloration. There were many dead trees of the first three species. These conditions were probably due to the dry seasons of the last two or three years. Native species, which are known to be susceptible to smoke injury, were noted en route from the principal street in Benicia to the arsenal grounds and found to be free from smoke markings.

Before reaching the place of witness No. 17 we passed a few old orchards in bad condition, notably an olive orchard and a few almond orchards, and these were free from smoke markings. An old vineyard west of this road was pointed out by Dr. Blankinship as a case in which smoke damage was alleged. This vineyard had not begun to develop the season's shoots, and nothing could be determined with reference to its condition.

On the place of witness No. 17 the orchard was in an abandoned condition and consisted of a few trees back of the house and a few in a pasture lot. About the residence a cypress tree was observed with considerable discoloration, evidently resulting from the death of limbs and twigs. One pine tree was dead and another was in good condition. Oats just beyond the house lot were several inches high and the area was quite weedy. The remainder of an old vineyard in a pasture area, apparently abandoned, was observed.

Across the road, on property which appeared to belong to the heirs of witness No. 35, wild oats, with scattering plants of other grain intermixed, were a few inches in height and in good condition, save for

the presence of fungous spots and some yellowish discoloration of the barley blades. Opposite the residence of witness No. 16 farther up the road a plat of oats was quite thin on the ground and only a few inches in height. Native species along the fence were in good condition and free from discoloration.

On the place of witness No. 18 a rather long row of almond trees extended along the road and back some distance along a division fence. These trees were in leaf and some nuts had formed. The trees were rather small and in a somewhat neglected condition, especially in a low area near the corner of the border. An occasional leaf showed a spot of discoloration usually extending across the outer end. An avenue of peppers along the private roadway showed some discoloration. The trees were rather small and stunted in the central portion of this avenue but larger at each end. The family orchard and ornamental plants were noted, but not closely examined.

On the place of witness No. 19, at an abrupt turn in the road a rather large number of eucalyptus, cypress, and oak trees were observed. Some of the cypress trees were dying. The oaks were rather gnarly, largely from insect galls. An almond orchard on the hill adjoining the residence was in leaf. Certain pear trees in a low area near the road were in bloom. Native species were observed and found to be in normal condition. Barley opposite the residence of witness No. 36 looked well and was several inches in height.

The property of witness No. 36 seemed to be a stopping place merely as there was nothing under cultivation in the small inclosure. The area consisted of a rather low basin and a steep hillside. A remnant of a vineyard occupied the highest part of the slope. A few fig, pear, and quince trees were standing about the house in an abandoned condition.

One of the most striking features of the property of witness No. 16 was the dense growth of thistle on the sides of the gulch about the residence of witness No. 36. Eucalyptus trees around the house showed some whitish spots such as described on other places. The younger trees with the broad leaves were commonly free from this discoloration. A young orchard of various sorts, peaches, cherries, figs, and quinces, and a rather large vineyard were noted. North of the residence a plat of oats was several inches in height and fairly uniform. The stand was good. Mustard was abundant in spots. No discoloration was noted on any of the cultivated or native species.

On the place of witness No. 29 a field of barley was noted north of the road on heavy adobe soil. The plants were several inches high and in normal condition. Beyond this on the hills what appeared to be an oat field was observed only from a distance. About the residence cypress, locust, pepper, and eucalyptus trees were standing,

the locust trees being somewhat sickly. Fig and pear trees scattered about were neglected and unkept. An area in front of the residence had been staked, apparently for grapes.

On the tract of witness No. 21 cypress, pepper, and eucalyptus trees about the house were found to be in normal condition. Wheat was nearly a foot high with some oat plants intermixed, and a rather large number of mustard plants. No discoloration was noted.

On the places of witnesses Nos. 24 and 28 there seemed to be only volunteer crops. On the former the wild oats were spotted with Helminthosporium. Mustard was very abundant. The gulches across the creek supported a luxuriant growth of thistles.

On the place of witness No. 27 grain was very thrifty in appearance close to the fence and a little shorter in the open field. At a point near the property of witness No. 37 the wild oats showed a distinct terminal bleaching of the blades, but not closely resembling smoke injury. The bleaching had occurred some time earlier, and its exact cause could not be determined. Wheat was nearly a foot high in the main field and about 2 feet high along the border. An old vineyard was noted beyond the pumping station.

On the property of witness No. 37 a large assortment of ornamental plants about the residence was in good condition. East of the road an area of alfalfa and grain was observed, the former showing some mildew.

On the remaining places along the road no special notes were made except that volunteer grain was observed from time to time, as were also native species and shade trees, and found to be free from evidences of smoke injury. On the place of witness No. 38 alfalfa plants were closely examined and found to be in normal condition.

March 28, 1914.—Pear trees on the place of witness No. 17 were in bloom. The oats were about a foot in height and free from discoloration. Fig trees were beginning to open their leaves.

Opposite this place on the property of witness No. 35 a rather large number of native species, including filaree, burr clover, mustard, chickweed, and dock were examined. The dock was somewhat infected with a fungus, probably Ovularia, which produces round spots. Thrips markings were numerous on the barley plants. The lower blades showed whitish margins and considerable yellowish tissue.

Opposite the residence of witness No. 16 the oats had developed two and three culms per plant. Native species as well as cultivated species were free from signs of smoke injury.

On the place of witness No. 18 the quince trees were in flower and showed some discoloration due to the normal death of the oldest leaves. Roses, apples, figs, cherries, apricots, and peaches were in normal condition, save that the cherries were not thrifty. The almond trees

appeared to be in full leaf and nuts were quite well developed. Barley on plowed land opposite the residence of witness No. 19 was in good condition. It had reached a height of about 6 inches. There was a small amount of yellowish discoloration present, and whitish margins were noted on certain blades. Filaree, mustard, burr clover, and an aquatic butter cup (*Ranunculus muricatus*) were noted and found to be free from discoloration.

Several pear trees on the place of witness No. 19 had gone out of bloom and others were in full bloom. Many dead twigs were noted on the oak trees. Mustard, chickweed, burr clover, and volunteer grain were examined and found to be normal.

On the place of witness No. 16 shoots were developing in the vineyard and were several inches in length. Most of the orchard varieties were in leaf. The oats north of the residence were about a foot in height and quite uniform. Mustard was abundant in spots. No discoloration of either was noted.

Barley on the place of witness No. 29 was about a foot in height. The old orchard trees had not been pruned nor cultivated.

The grain on the place of witness No. 21 was 12 to 14 inches in height, and no discoloration of either the wild oats or the wheat was noted.

On the place of witness No. 27 the grain along the border—mostly wild oats—was about 3 feet high. Mustard among these plants was 5 to 6 feet high. The wheat was about a foot in height in the open field. Leaves were developing on the vines in spots. Other areas were still dormant. The discoloration noted on the former date was still present, but was not progressing; that is, only those blades formerly noted in this condition were affected.

At other points along the road between this point and Vallejo, examinations were made of the native species and cultivated crops, and no conditions were found that suggested smoke injury.

From the reports on the various farms in the Vallejo-Benicia region, over which the emanations from the Selby smelter pass, it will be seen that during the period from March 12 to May 8 damage to vegetation was limited to a small area or strip along the water front extending from Vallejo to Glen Cove, approximately, and a small additional area on the water front in Benicia. The number of species affected was small—barley, wild oats, broncho or brome grass, a few other varieties of grass, burr clover, mustard, filaree, Anagallis, mallow, Eriogonum, chickweed, and lupine. The barley, broncho grass, filaree, and mallow were the only species affected beyond a small area about the so-called Dos Reis Cove. At this point there were few fumigations of sufficient strength to injure vegetation—really only one strong enough to approach economic damage even to barley, one of the most sensitive crops.

Examination of specimens taken on the various farms suggests the desirablility of qualifying the above statement. A few barley blades, taken on the place of witness No. 32, were marked by small white spots slightly stained in a manner closely resembling, if not identical with, markings produced by sulphur dioxide in the experimental fumigation work. When these samples were taken the idea of smelter smoke as a casual agent was abandoned for the reasons that there were so few to be found, and the place of witness No. 32 did not seem exposed to smoke injury, and further that these markings were not those commonly found about smelters. Such markings were most numerous in the test plats given weak fumigations. It is to be noted that the place of witness No. 32 is in line with the place of witness No. 132 (where there were distinct smoke markings) and the smelter.

I am strongly of the opinion that the foliar markings of the barley and other plants affected by the gas from the smelter were insufficient to cause material reduction in the yield of crops in question.

Had my investigation begun a little earlier in the season it would have covered the part of the year in which damage to grain crops is possible. The period covered was sufficient to warrant the statement that there was no damage to spring and winter sown grain beyond the conditions above noted, as it was possible in the case of all grain or grain hay fields, save volunteer crops, to determine the fact of earlier injury or the absence of it by an examination of the oldest grain blades.

Orchard varieties and most of the truck crops, being less sensitive to smoke injury than grain (barley and oats), it does not seem probable that there was any damage inflicted through that channel. All orchards and gardens were a mile or more from the point of greatest damage. The residence lot and orchard on the place of witness No. 25 was almost directly in the line of the strongest fumigation (or perhaps it would be more nearly correct to say the most effective fumigation), and in this case there was a wide expanse of rolling territory between the point of most noticeable effect and the garden. Beyond one barley blade, which showed the characteristic discoloration of smoke injury, there was apparently no effect on the place of witness No. 25 throughout the period. As it is possible to find isolated specimens of almost every species beyond the possible limit of smoke injury which are marked by some other agent in a manner almost, if not quite, indistinguishable from the effects of smelter smoke, it does not seem justifiable to attribute a discoloration of one leaf or one blade of any species to smelter smoke when there is no other evidence.

The greater part of the area in which smoke markings were observable during the period of this investigation was not under cultivation

but was devoted to pasturage. Most of the vegetation over this area consisted of early maturing species such as filaree, burr clover, and certain annual grasses. Thus the hills early assumed a brownish or discolored appearance. This was pointed out on one or more occasions as evidence of smoke damage.

During the investigation particular care was taken to avoid conversation with farmers living in the community and all others who might be complainants, but several persons did break through the line of defense on various occasions. Witness No. 45, residing well out toward the western limits of Benicia, and one of his neighbors gave information relative to the "unbearableness" of the "gas" and "acids" from the smelter on the water and in the vicinity of their homes. Witness made loud complaint of damage to fruit trees and garden truck on his own place. An examination revealed no trace of smoke injury, though some of the most sensitive kinds of vegetation were present.

Witness's neighbor, witness No. 76, complained of damage to potatoes, alleging that they did not grow any more when the wind turned to the west, which happened late in April or early in May. Such beliefs are doubtless founded upon the fact that potatoes begin to show the presence of diseases (early blight, wilt, and rosette) about the time indicated. The potato is not at all sensitive to smelter smoke.

Witness No. 11 was of the opinion that the soil had been poisoned, which ought to account for his shortage in wheat, and asserted that the greatest damage from smelter fumes occurred in the fall when vegetation was dry, a hypothesis considerably at variance with facts. The fall damage referred to pertained mostly to stock, as it was thought that there was by that time an accumulation of poisonous material in or on the blades of grass.

Witness No. 4, without knowing what I was investigating, betrayed his feelings on the subject by stating that there was no use to attempt growing fruit or anything else, as nothing would grow while the smelter was in operation.

A woman living on the roadside at the west limits of Benicia stated that smoke was unendurable at certain times where she lived and that nothing grew in her garden as it ought on that account. No conditions whatever could be found in her garden, which contained a large assortment of plants, many of which were quite sensitive to sulphur dioxide, which would indicate smelter-smoke damage.

It was said that many people in the region complained of the odor of smelter smoke to the effect that it was sickening and nauseating. I was able to detect the odor of sulphur dioxide on one or two occasions while investigating in the region. The odor was quite faint, and was encountered at a point on the property of witnesses Nos. 1

and 1A some distance from any residence. The odor that pervades the atmosphere about the town of Oleum was encountered several times in the Vallejo-Benicia region. I have, myself, attributed the odor of bogs and various other odors to the emanations from a smelter in smelting communities, until I found that the direction of the wind was such that smelter emanations could not have been carried to the point at which the odor was noted. I have found many persons in smelting communities making such mistakes.

As irrigation water is not available, orcharding can not be practiced in the district except the raising of fruit for home consumption, and that only where water can be pumped or supplied in small quantities from spring runs. The family orchard on the place of witness No. 12 was well tilled and presented a fine appearance up to the end of this period of investigation, but favorable location with respect to soil and moisture conditions were probably the explanation. Of the two remaining family orchards under cultivation one looked fairly well but was not producing well. On nearly every place visited I noted several fruit trees of various sorts, neglected and generally in miserable condition. I found no evidence of smelter-smoke damage to fruit trees at any point visited.

Grain raising and pasturage seemed to be the only pursuits with any promise of profit that could be indulged in. Though the region is very rolling, most of the land seems to have been plowed and sowed to grain at some time. Grain can not be grown continuously on the same land and close pasturing will prove disastrous after a time to many of the common forage plants. Only those that fruit close to the ground are likely to survive many years. In general, then, I consider the region relatively low in agricultural value. To make a living in such a region farmers must be alert and active, putting forth every effort. Half-hearted farming in most instances accounts for the shortages complained of by residents of the smoke zone.

In reference to fungous diseases, two species of Helminthosporium were found on barley. One of these, *H. graminum*, was common on the place of witness No. 95. Its effects are noticeable quite early in the season. Infected plants show a sickly, dwarfed condition, accompanied by light streaks in the blades (called blade stripe), extending even to the bases of the sheaths. The discolored tissue becomes dark after a time. The kernels fail to mature, resulting in a condition referred to as dead head. Affected plants often yield nothing. The second species (unidentified) causes dark spots on the blades, frequently the premature death of entire blades.

A species of the same genus was common on oat blades, causing purple or brownish spots. This species was relatively unimportant though common.

DOCK DISEASE AND SPRAY INJURY.
1, Diseased Dock Leaf from Davis; 2, Diseased Dock Leaf from Vallejo;
3, Spray Injury to Leaf of Cherry Tree; 4, Spray Injury to Leaf of Apple Tree.

FUNGOUS INJURY TO BARLEY.
1, Blades from Place of Witness No. 25; 2, Blades from University Farm at Davis; 3, Blades from Place of Witness No. 12.

SMOKE INJURY TO GRAIN.

1, Wild oats from Place of Witnesses Nos. 1 and 2; 2, Barley from Place of Witness No. 132.

INJURY TO LEAVES BY ROOT DISEASE, LEAF MINER, AND CALICO BUG.
1, Injury by Root Disease, Leaves of Almond Tree; 2, Injury by Calico Bug, Leaves of Black Mustard; 3, Injury by Leaf Miner, Leaves of Wind-Mill Pink; 4, Injury by Leaf Miner, Leaves of Lupine.

CHLOROTIC CONDITION OF BARLEY FROM VALLEJO FIELD, OUTSIDE OF EXPERIMENTAL PLOTS

In certain fields mildew was abundant, causing premature death to oat blades.

A species of rye grass was found badly infected with a smut, causing splitting of the blades and sheaths. This species of grass was not important as stock feed on account of its tough inedible character.

Several other varieties of grass were infected with leaf-spot fungi which caused considerable discoloration of the blades and premature death of many.

Considerable work has lately been done upon the subject of wheat infections by soil fungi. The idea is becoming common, among plant pathologists, that the continued growing of one crop on the same soil results in decline in yield not so much on account of exhaustion of the soil as on account of the multiplication of soil organisms that attack the roots and even the above-ground parts of the crop. In one experiment that I conducted, elsewhere, wheat plats sprinkled with soil from old wheat land yielded considerably less than similar plats without the sprinkling of old wheat land soil.

As to insect pests a tortricid leaf roller was found defoliating pear trees in one orchard and doing considerable damage to pears and plums in other orchards.

The greatest infestation of woolly aphis I have ever seen was noted on apple trees in the orchard of witness No. 5, where it was evident that trees were being killed by that pest.

The prune aphis was abundant on some places.

Several species of scale insects were noted in most of the orchards examined. In some instances the infestation was light, though in others it was rather serious.

On several native species of vegetation I found leaf-miner injury (See Pl. XXXVI) and markings produced by moth larvæ that might readily be taken for smoke injury. This does not signify any close resemblance to smoke injury, as unscientific persons point out every sort of scratch or blemish of plant leaves as evidence of smoke injury.

One of the most important cases of insect injury was that of the Hessian fly on the place of witness No. 23, elsewhere discussed.

Other insect pests and fungous disease were found in the region, but reference to each specifically is not thought necessary.

INSECT PESTS IN THE SELBY SMOKE ZONE.

By R. W. Doane.

INTRODUCTION.

Following the instructions of the commission I made several trips to the Selby smoke zone during October and November, 1913, to study the condition of the orchards and other vegetation there and to note particularly to what extent the existing injury was due to insects.

In January, 1914, I began a short series of experiments or demonstrations to show that with proper cultivation, pruning, and spraying many of the orchards which are now almost worthless could be brought into bearing again and produce a normal amount of good, clean fruit. On account of pressure of other work these demonstrations were not pushed to their logical end, but enough was done to show conclusively that a large part of the trouble that is ordinarily charged to smelter-smoke injury is due to lack of care in the orchard or field.

Most of the orchards in this region are small home orchards, containing a few trees of various kinds, intended to furnish fruit for home use. There are few large orchards where fruit raising is conducted on a commercial basis, and I visited no orchards that showed that they had been cared for as an orchard must be cared for if it is going to yield the returns that it should. In the very best fruit-growing sections, under the most favorable conditions, it is necessary to pay careful attention to the condition of the soil and to pruning and spraying if profitable returns are to be expected. Many of the orchards, particularly the small ones, in the region studied remain unplowed from year to year. Often they are used for pasture. Very few show evidence of careful, intelligent pruning, and I believe that very few, if any, of them have ever been sprayed.

Neglected, unplowed orchards are hardly worthy of consideration, because such places have little fruit and contain many dead and dying trees in whatever region they may be found. Usually the insect pests and plant diseases play a prominent part in bringing about the early destruction of the trees in these orchards.

I will not now attempt to give a complete list of the injurious insects in the orchards of the smoke zone, but will call attention to a few that are of particular interest, because the damage they do is often mistaken for injury due to smelter smoke.

Several species of scale insects are common in nearly all of the orchards. The black scale, *Saisseta oleae* Bern., is in practically all orchards. Like other scale insects of this group, the black scale secretes an abundance of honeydew, minute drops of which fall on the leaves and branches, often covering them with a sweet sticky coating in which a black sooty mold grows, giving the trees a noticeable black appearance. This black smut on the trees is the thing that is most commonly complained of, as practically all of the people in the smoke zone believe it to be due to smelter smoke. It not only covers the leaves and branches of the tree, but is often all over the trunk of the tree and sometimes covers the fruit to such an extent as to make it most unattractive. I may say in passing that not only the fruit growers of the smoke zone, but many others who have had their attention called to the conditions there, believe the black smut is due to smelter smoke, and if this factor could be removed from the case most of the orchardists would find much less cause for believing that their trees were being injured by the smelter. I believe, too, that when they know the true source of the trouble many of them will take steps to control the scale insects.

The brown apricot scale, *Lecanium corni* Bouche, is also found in many of the orchards. In many places this is often regarded as one of the serious pests of orchard and other trees, not only on account of the damage that the insects do by sucking the sap from the plant, but because they secrete so much honeydew that the fruit and leaves of the trees often become covered with the black, sooty mold.

The frosted scale, *Lecanium pruinosum* Coq., is also found throughout the smoke zone, but it is not as abundant as the black scale and the brown apricot scale. Its appearance and habits are somewhat like the last-named species.

Belonging to the same group of scale insects is the soft brown scale, *Coccus hesperidum* Linn, which is found very commonly on citrus trees. Practically all of the orange and lemon trees in the smoke zone were more or less seriously infested, and as this insect, too, secretes an abundance of honeydew, the leaves and fruit were usually covered with the black, sooty mold which grows in this secretion.

The cottony cushion scale, *Icerya purchasi* Mask., was found on many of the citrus trees. It, too, secretes an abundance of honeydew. Without an exception, the owners of the trees that were infested with these scale insects believed that the black, sooty mold on the leaves and fruit was due to smelter smoke, and it was often difficult to convince them that the trees could be kept clean if the insects were destroyed.

The San José scale, *Aspidiotus perniciosus* Comst., which has been long regarded as one of the most serious pests of fruit trees, was found in many orchards in the smoke zone. Some apple trees were found to

have the bark of the trunk and larger limbs quite covered with this insect, and the trees showed very clearly that they were suffering as a result of this heavy infestation. As the insects are so small and the scaly covering is just the color of the bark, the owners of the trees usually do not know that the pest is in their orchards until attention is called to it by some one who readily recognizes the insect and its work.

Within recent years the European pear scale, *Epidiaspis pyricola* Del Guercio, has come to be regarded by many as a pest almost as important as the San José scale in some parts of California at least. The scale of the female is very similar to that of the San José scale, and may readily be mistaken for it unless examined carefully. The scale of the male is, however, quite distinct, being elongate and white.

The European pear scales are often found under the moss on the trees. For this reason they may be easily overlooked, even if one is examining the trees for them. The moss protects them from their natural enemies and makes it more difficult to kill the insects with any spray material. Best results are obtained by using a spray that will clean the moss from the tree as well as kill the insects.

This pest is common in the Selby smoke zone and many trees are being killed by it, the owners, of course, charging the trouble to smelter smoke.

The greedy scale, *Aspidiotus rapax* Comst., is also common throughout the smoke zone, but it is not usually regarded as a serious pest.

The oleander scale, *Aspidiotus hederae* Vall., like the greedy scale, is a common insect on a great variety of plants in many places, and is not usually regarded as a serious pest. Sometimes, however, it occurs in great numbers, or attacks plants that are particularly susceptible to injury by it, and considerable loss may result. In a large field of currant bushes I noticed that many of the bushes were dying in spots throughout the field. I was unable to account for this condition until I dug down and found the crown and the roots badly infested with this scale insect. An examination of other dead or dying bushes and a comparison with bushes on which few or no scale insects occurred, showed that this pest was responsible for the death of many bushes throughout the field.

The oyster-shell scale, *Lepidosaphes ulmi* Linn., is a larger, much more conspicuous, insect than any of the members of the genus *Aspidiotus*. It occurs in incredible numbers throughout the smoke zone, often literally covering the whole tree. Light infestations of this insect are not usually regarded as serious, but when it becomes as abundant as it often is here, the trees can not but suffer.

The cypress Sphaerococcus, *Sphaerococcus cuppressi* Ehrh., is an important enemy of the Monterey cypress in the smoke zone. Many of the trees that have died or are dying are badly infested with this

pest, and it is doubtless one of the important factors that has brought about the present deplorable condition of so many of the trees. It is more fully discussed on a later page.

The woolly aphis, *Schizoneura lanigera* Hausm., is common in all of the orchards of the smoke zone. In some of the younger orchards it is seriously injuring the trees. It occurs on both the roots and the branches, being easily detected on account of the white woolly secretion that covers the insects as they group themselves on the underside of young twigs or shoots or on the new growth around any kind of a wound. They often cause considerable knots or swellings on the affected parts of the trees. The roots particularly are apt to become badly affected and misshapen on account of the many galls that characterize the work of this pest.

In this way many of the smaller roots are entirely destroyed and young trees are thus seriously injured, and if not killed outright, they become so stunted that they never make the trees they should have made. It is a difficult insect to control, as it is hard to get anything that will penetrate the soil and kill the insects without injuring the tree. Nurserymen should not be allowed to sell growers infested nursery stock.

The rosy apple aphis, *Aphis sorbi* Kalt., is another serious pest of the apple trees in the smoke zone, doing particular damage to young apple trees by curling and destroying the leaves and thus keeping them from performing their normal function. As this aphis works only above the ground, its work is much more evident to the grower and can hardly be mistaken for anything else. But it secretes a great deal of honeydew, in which the black, sooty mold grows, and this is usually charged to smelter smoke.

The mealy plum louse, *Hyalopterus arundinis* Fab., is the most abundant aphis in the smoke region attacking plums. The first broods hatch from eggs that have passed the winter on the twigs. The young aphids settle on the under sides of the young leaves and begin feeding. They soon begin to give birth to living young, which, in turn, produce other generations. Early in the summer the number of these pests have increased to such an extent that they cover the under sides of most of the leaves on many trees. Such infested leaves usually do not curl, but they soon turn yellow and fall early. Before midsummer, most of the aphids have left the prune trees, having acquired wings and migrated to grasses where they feed until fall. A few migrants return to the trees in the fall and a generation is produced that lays the winter eggs.

As these aphids are just the color of the leaves, they may often remain unnoticed, even when they occur in great enough numbers to cover the under sides of the leaves. The great amount of honeydew that they secrete soon attracts attention because the leaves

become sticky and the black, sooty mold soon begins to grow in it. In many orchards the trees become very black on account of the great amount of this honeydew. Unfortunately, the sooty mold remains on the tree long after the aphids have left it, and the grower, at a loss to explain the presence of the black substance on his trees in any other way, charges it up to smelter smoke. Again and again I explained the relation of the scale insects and the aphids to the orchardists in the smoke region, but to most of them the smelter smoke was an easier explanation, and so was the one usually accepted.

There are still other insects that by secreting honeydew cause the leaves of the plant on which they are feeding to become blackened by the growth of black fungi, but attention will be called to only one more. The grape-leaf hopper, *Typhlocyba comes* Say., feeds on the grapevine leaves, often conspicuously spotting and blackening them. As the insect sucks the sap from the leaf, small white spots are made where the beak has been inserted. Sometimes these spots are so numerous that they coalesce and form dry, brown patches. Badly infested leaves usually dry and fall early. As the insects are feeding they secrete more or less honeydew, but more disgusting still are the small, black spots of excreta that often cover the leaves and berries, making the latter unfit for food unless they are washed.

The work of the apple-leaf hoppers, *Empoasca mali* LeB., on the apple leaves is much like that of the grapevine leaf hopper on the foliage of the grape. Although this insect is common throughout the smoke region, it is not of much economic importance, and is listed only because the effect of its work on the leaves may be mistaken for smelter-smoke injury.

Other species of leaf hoppers occur on many other plants, melon vines, cucumber vines, and other garden plants, often suffering considerably from the attacks of these insects, which suck the sap from the leaves and cause them to dry and turn brown prematurely.

The pear thrips, *Euthrips pyri* Daniel, was found commonly throughout the orchards in the smoke zone, but we did not see them abundant enough in any of the orchards to be of much economic importance this year. The history of this pest in Santa Clara Valley shows us that it may become of prime importance where climatic and other conditions are favorable.

The bean thrips, *Heliothrips fasciatus* Pergande, was much more abundant and in many gardens was doing a great deal of damage to almost all kinds of garden truck. As it usually works on the under sides of the leaves, it does not usually attract attention, and the dried, yellowish or brownish condition of the leaves is apt to be ascribed to other causes.

The spotted flower beetle, *Diabrotica soror* Lec., is also a common garden pest, as it feeds on the foliage of almost all kinds of cultivated

plants, sometimes almost, or quite, defoliating them, and often ruining the blossoms. The beetle is easily seen and its work is distinct, so it need not be confused with anything else.

A small, red mite, *Bryobia pratensis* Garman, commonly known as the "red spider," is destructively abundant in many orchards, doing particular damage to almond trees. The eggs of this mite are to be found during the winter on the under sides of branches of the tree. As soon as the first leaves begin to unfold the mites are ready to begin feeding on them and often a very small leaf will be attacked by more than a score of these little pests. As the leaves grow larger, they become more seriously affected, and long before they have attained their normal size and development, they begin to turn grayish, then brownish, and, in bad seasons, many almond trees are often defoliated before midsummer.

As the mites are so small that they can hardly be seen except with the aid of a lens, their presence on the trees is usually not noticed by the orchardist, and the discolored leaves and early falling is thought to be due to smelter smoke.

Another mite, the two-spotted mite, *Tetranychus bimaculatus* Harv., is sometimes also called "red spider." This occurs on plums, prunes, berries, and many other trees and plants, sometimes almost or quite defoliating them early in the season. While present in many orchards and gardens in the Selby smoke zone, it does not seem to be as important as *Bryobia*.

The pear-leaf blister mite, *Eriophes pyri* Pgst., enters the pear leaves while they are very small, sometimes while they are yet in the bud. As it feeds within the tissues of the leaf, it causes conspicuous red spots, which later may become greenish, then brown. Although many orchardists are familiar with the work of this insect and its effect on the leaf, not a few in the smoke zone believe that the spots on the leaves are caused by smelter smoke.

The work of the pear slug, *Caliroa cerasi* Linn, is distinctive and need not be, but frequently is, mistaken for other injury. These slug-like larvae feed on the upper surface of the leaf, eating away all the green part and causing the lower part to dry and turn brown. The adults are small black sawflies.

The peach-twig borer, *Anarsia lineatella* Zell., bores its way into the tender young shoots on the peach trees, often killing in this way a large part of the new growth, particularly on young trees, where the evidences of its work are most prominent. The dead twigs at once attract attention, and as there is no external evidence of insect or other injury some orchardists believe this condition to be due to smelter-smoke injury. Most of the growers, however, recognize the work of this insect.

A small black weevil, which seems only recently to have developed into a pest of any importance, was found feeding on the young leaves of peach, plum, cherry, and apple trees, being particularly abundant during April. When the infestation is bad, nearly all of the foliage may be destroyed. In one orchard this weevil and the leaf rollers quite defoliated a young apple tree. New leaves will soon be formed, but the retarding of the development of the tree, caused by the loss of so many of the first leaves, may be of much importance.

The codling moth, *Cydia pomonella* Linn., is common in all orchards. No efforts are made to control it in the Selby smoke zone. Everyone is familiar with the worm in the apples and pears, but few realize that these larvae are responsible for so much of the fruit dropping early in the season. Many times our attention was called to the fact that the apples and pears dropped from the trees early in the season, before they were mature. The orchardists believed that this was because the smelter smoke had injured the trees or the fruit. We were not in the orchards when the fruit was falling, but as nearly all of the fruit that remained on the trees was infested with the coddling-moth larvae, it is safe to say that a large percentage of the fruit that fell was also infested.

Throughout the region covered by the investigation many of the grapevines were found to be dying. Neglect was possibly responsible for the death of some of these vines, but the grapevine phylloxera, *Phylloxera vastatrix* Planchon, probably killed many more. This insect works in a vineyard in such a way that unless one is familiar with the effects on the vines its presence may never be suspected. The phylloxera, which are very small bronze-colored aphis, attack the healthy roots, usually causing a swelling at the point where they puncture the tissue. When the infestation is severe these gall-like growths may be so common as to almost or quite touch each other, and as the cells in the affected parts soon break up and decay, the whole root system may be seriously affected. In this way the young, vigorous roots may early be destroyed, and the vine killed outright, or, if the infestation is a little less severe, the vine may become weakened but live for a long while in an unthrifty condition, bearing little or no fruit. The phylloxera do not seem to thrive on such weakened vines, and an examination may fail to reveal any on the roots, but an examination of comparatively healthy vines near by will usually reveal the insects.

I do not know that this insect has been reported from this region before. None of the growers suspected its presence in their vineyards, and many, being at a loss to account for the condition of their vines, held the smelter smoke to be responsible for the injury.

Some of the grapevine roots examined looked as if they had been injured by the grape-root worm, *Adoxus obscurus* Linn., but none of

the insects was found, and I am not sure that it occurs in the smoke zone.

In the Carquinez cemetery and other places many of the Monterey cypress trees are dying. I have already called attention to the scale insects that are attacking these trees and doubtless doing more or less injury, but not being entirely responsible for the death of the trees. As soon as one of these trees is weakened from any cause it may be attacked by hordes of small beetles, *Phloeosinus cupressi* Hopk., which bore into the cambium and make longitudinal chambers in which they lay their eggs. The larvae that hatch from these eggs bore out at right angles from the brood chamber, and if many of them are in the tree they soon girdle it. Many trees that might have survived temporary unfavorable conditions are thus entirely destroyed, for as soon as these beetles begin working in the cambium the tree is doomed.

The same insects sometimes attack the twigs and smaller limbs of Monterey cypress that are apparently in full vigor, and in this way may do considerable damage. In some places in the smoke zone I found trees which showed this work conspicuously.

This same insect is known throughout some parts of California as the most important pest of the Lawson cypress, for it affects not only the twigs, but bores into the cambium of the trees when they are seemingly perfectly sound. The burrows made by the beetles and the larvae kill the trees in a short time. Some investigators believe that the beetle may in the same way attack sound Monterey cypress and kill them, but others think that these trees must first be weakened by drought or some other agent.

Many of the Monterey cypress trees in the vicinity of Palo Alto and Stanford University are now dying in the same way as were the trees in the Carquinez cemetery and around Benicia. With the aid of an advanced student I am now making a study of these trees. Sometimes a score or more of these trees will be found to be dying in small groves or rows. As soon as the trees begin to show signs of dying, we find the beetles at work in them, but we are not yet convinced that the beetles are the primary cause of the trouble. As some of these dying trees are to be found on the hillsides and others in the valleys, the location or soil does not seem to be an important factor.

My whole time during the days that I was engaged in this work was given to the study of the trees, vines, and garden plants. No study was made of the insects that were infesting the wheat or other grains. Since finishing this work one of the plant pathologists, Mr. W. W. Jones, submitted to me specimens of wheat straws he had collected on one of the farms near Benicia. An examination of

these showed that they were very badly infested with Hessian fly, the insect being found at that time in the pupal or "flaxseed" stage. Mr. Jones will doubtless report on the condition of the field at the time he collected these specimens, and I will add a few words in regard to the way this insect works and affects the plants.

The flies lay their eggs on the leaves, and the young larvæ which hatch from them make their way toward the base of the stem, where, protected by the leaf sheath, they begin sucking the juice from the plant. The young wheat when attacked in the fall usually turns yellow, and if the attack is serious, stops growing. The pest usually appears first in the less thrifty parts of the field, but if the infestation is bad, it may show up over the whole field. Often the main plant is destroyed and tillers or side shoots are formed; thus there will often be formed many small stems instead of fewer strong, thrifty stems. When the larva becomes full grown it changes to a pupal stage. The pupa case is small, brown, flattened, oval, and looks so much like a flaxseed that this stage is commonly known as the "flaxseed" stage. It was this stage that I found in the wheat stems that Mr. Jones submitted to me. The insect passes the winter in this stage and the flies that issue early in the spring lay their eggs on the young spring wheat, and much damage may result from the attacks of this spring brood. There may be two or three, or even four generations during the year in some localities.

This insect has never been a very serious pest in California, and its life history has not been carefully worked out here. Under certain conditions, however, it sometimes becomes of considerable economic importance, particularly in the San Francisco Bay region. It seems that the interior valleys are too dry for its development.

THE DEMONSTRATION EXPERIMENT.

Realizing that the poor condition of many of the orchards in the region where these investigations were being made was due to lack of cultivation, pruning, and spraying, I planned a short series of experiments to try to demonstrate what might be done in some of these orchards if they were given proper care. Unfavorable weather conditions and the difficulty I had in getting the work done interfered greatly with my plans, but enough was accomplished to show that the trees, if not already too far gone from neglect, will quickly respond to proper treatment.

These experiments were conducted on three different places. One of the orchards selected was on the place of witness No. 24, just east of Benicia. This orchard is situated on the hillside west of the house and contains 50 or 60 trees, including a few apricot, plum, cherry, pear, and apple trees. On the place of witness No. 26, just north, a few trees that were badly infested with the European pear scale,

Epidiaspis pyricola Del Guercio, were selected for treatment. The other trees used in the experiments were on the place of witness No. 5 in Glen Cove. We had planned to do the first work in December, but the rainy weather made this impracticable.

On January 9 I went into the orchard of witness No. 24, ready to spray, but found that the trees had not yet been pruned. This made it impossible to give them as thorough a treatment as I would have liked to have given them, but as the season was getting late, I sprayed a few of the trees as follows:

Five peach trees, one small apple tree, one pear tree, one damson plum tree, one apricot tree, using "Rex sulphur-lime" spray at the rate of 1 part to 10 parts of water. The apple tree was badly affected with oyster-shell scale, *Lepidosaphes ulmi* Linn. As the overwintering eggs of this insect are safely protected underneath the body of the old scale, I hardly expected to kill them by this treatment, but thought the experiment might be worth while. The rest of the trees were all badly affected with black scale, *Lecanium oleae* Bern., and some of them had a few greedy scales, *Aspidiotus rapax* Comst. Most of these trees were very black because of the presence of the black sooty mold that grows in the honeydew that is secreted by black scale and by aphis.

On February 14, I found that all of the trees in this orchard had been severely pruned. So many of the small limbs had been removed that the trunks of the trees were badly exposed, and they may suffer from the direct rays of the sun during the warm spring and early summer. But this pruning made the trees easier to spray, and as I was not thoroughly satisfied with my first spraying, I gave all the trees a second treatment, using the same materials at the same strength. The buds were just beginning to swell on all of these trees, but they were not opened far enough to make it dangerous to use the spray at this strength.

On the same day I selected three other peach trees and sprayed them with distillate emulsion, using 1 gallon of the emulsion to 16 gallons of water. These trees were badly infested with black scale. The orchard had not yet been plowed.

January 10 I found that witness No. 5 had pruned a few almond and prune trees. On this day I sprayed four almond trees, four prune trees, and four small apricot trees, the apricot trees and two of the prune trees had not been pruned. I used the sulphur-lime spray, 1 part to 10 of water. The day was cold and there was a little wind and fog, but we succeeded in getting the trees covered fairly well.

January 31 I sprayed again in the orchard of witness No. 5, using "Rex distillate emulsion," 1 part to 16 parts of water. In this experiment I used three unpruned prune trees just above the ones that had been sprayed with "sulphur lime." The almond trees were

badly infested with black scale and the lower sides of most of the limbs were literally covered with the eggs of the red spider or mite, *Bryobia pratensis* Garman. The prune trees were badly infested with black scale, while the apricot trees had only a few black scales.

February 14 I sprayed two small plum trees and two small pear trees in the orchard of witness No. 26. These trees were badly infested with European pear scale, *Epidiaspis pyricola* Del Guercio. In this experiment we used a distillate emulsion, 1 to 16.

March 7 I inspected the sprayed trees in the orchards of witnesses Nos. 5 and 26 to determine whether the spraying had had any effect on the time of blossoming. I could notice no perceptible difference in the amount of blossoms on the sprayed and the unsprayed trees. The peach trees were all just beginning to bloom at this time. The apricot trees showed only a few blossoms. The plum tree was just beginning to bloom. All of the almond trees in the orchard of witness No. 5 had dropped most of their blossoms and there appeared to be a fairly good set of nuts on all of the trees. At this time I noted no difference in the amount of almonds on the sprayed and unsprayed trees. The red spiders, or mites, had already begun to hatch on both the sprayed and unsprayed trees, although they were less abundant on the former. On the unsprayed trees many of the small leaves were already showing the effects of the spiders' work. One leaf, less than an inch long, had 53 of the mites feeding on it. Such leaves as this were already badly injured by the mites. While many of the eggs on the sprayed trees were hatching, the young mites seemed to be killed very soon after they issued, so that the leaves were not at all affected by them.

Most of the scale insects on the sprayed trees seemed to have been killed. The almond trees and the prune trees that had been sprayed with sulphur lime were looking much cleaner and brighter than the unsprayed trees. The prune trees that had been sprayed with distillate were still rather black and did not look any better than the unsprayed trees. I had expected that the distillate would clean the sooty mold off of the trees, but it did not seem to do it. A crude-oil emulsion would probably have served this purpose much better.

March 9 I examined the trees in the orchard of witness No. 26 that had been sprayed with the distillate, and found that nearly all of the scale had been killed, but a few live insects were to be found under the old bark in places where the spray had not penetrated.

April 11 I again inspected the orchard of witness of No. 24; it had recently been plowed. The ground evidently was not in good condition when it was plowed, for it was left in big chunks that would dry out rapidly and be hard to put into good condition unless more rains should soften the clods so that they could be harrowed to pieces. The black scale, *Saisseta oleal* Bern., on the unsprayed peach trees were

from one-quarter to one-half grown, and appeared in considerable numbers. There were also some frosty scales, *Lecanium pruinosum* Coq., that were about one-half grown, and were secreting considerable honeydew, which was dropping on the leaves directly below them. Few scales were to be found on the trees that were sprayed, and nearly all of these were dead. The mealy plum aphis, *Hyalopterus arundinis* Fab., were abundant on the plum trees, the undersides of many of the leaves were entirely covered, and on some of the twigs nearly all of the leaves were infested. These aphis were present on both the sprayed and unsprayed trees.

On the same day I visited again the orchard of witness No. 5. A comparison of the sprayed and unsprayed almond trees showed a striking difference in the number of scale insects and red spiders. Some of the limbs on the unsprayed trees showed an abundance of scale insects one-quarter to one-half grown, but they did not seem to be secreting honeydew at that time. The red spiders, or mites, were also bad on some of these trees. The young mites occurred in great masses among the eggs on the undersides of the limbs. They were also scattering through the leaves, many of the leaves being already pale and spotted on account of their work. The leaves on the sprayed trees were bright and clean and unspotted, and looked particularly fine when compared with the leaves of the unsprayed trees. There seemed to be more almonds on the sprayed than on the unsprayed trees.

The unsprayed prune trees showed a great many black scales one-quarter to one-half grown, and a few frosty scales. The aphis were rather abundant on the lower sides of the leaves. Three of the sprayed prune trees showed few scale insects, the fourth showed a few more, but not nearly so many as were found on the unsprayed trees. The three prune trees that were sprayed with the distillate had practically no scale on them, but they had aphis. All of the prune trees have bloomed heavily, but the set of prunes is light.

April 25, in company with two members of the commission, Messrs. Franklin and Gould, and Mr. Wells, of the commission staff, I again visited the orchards where the spraying had been done. The difference in the sprayed and unsprayed trees was even more striking than before.

In the orchard of witness No. 5 the leaves on the sprayed almond were clean and bright, with a healthy growth of foliage and a good set of nuts, while the unsprayed trees showed conspicuously the markings and coloring due to the attacks of the red spider. The scale on the unsprayed trees was also conspicuous, as most of them were nearly full grown. We found no scale on the sprayed almond trees. Many of the prune trees in this orchard, including those that had been sprayed, were badly infested with aphids *Hyalopterus arundinis* Fab.; the honeydew

that they secrete was already conspicuous on the leaves. It was suggested that it might be worth while to spray some of these trees with some insecticide that would kill the aphids. But as the season was well advanced and as the aphids had already inflicted almost as much injury as they could before their summer migration or before their natural enemies began to control them, I did not think it would be worth the while to spray these trees for demonstration purposes only. The presence on the leaves of the honeydew would cause the black, sooty mold to cover them so that much of the value of this demonstration on the prune trees would be lost for the sprayed prune trees would be almost or quite as black as the unsprayed trees. If these trees had been sprayed for the aphis earlier, they would have been in good condition. As most of the apricot trees in this orchard were in good condition, the effect of the spraying on the four apricot trees was not apparent.

In the orchard of witness No. 24 the difference between the sprayed and the unsprayed trees was not as noticeable as in the orchard of witness No. 5. Examination showed that the nearly full-grown scales were fairly abundant on many of the unsprayed trees; none was found on the sprayed trees. A more careful detailed examination may have shown a few scales on these sprayed trees, but it was evident that they would not be abundant enough to be of importance. The plum tree that was sprayed, as well as others unsprayed in the same orchard, was badly infested with aphis, *Hyalopterus arundinis* Fab., so it was to be expected that all of the plum trees, both sprayed and unsprayed, would be black with the sooty fungus later in the season. In this orchard I called the particular attention of the commissioners to the condition of some of the small apple trees that had been seriously injured by the attacks of rosy aphis, apple leaf rollers, and small black weevils. The weevil feeds on the foliage of the peach, plum, cherry, apple, and other trees. Its work was very noticeable on the peach trees, but was probably of more importance on some of the small apple trees, as it had destroyed such a large proportion of the already scanty foliage. Working with them were leaf rollers. These larvæ spin silken threads which fasten the edges of the leaves together, making a safe retreat within which they can feed on the tissues of the leaves or from which they can make excursions to other leaves. Where several of these are present on the tree, as they were in some instances in this orchard, the foliage is seriously affected. Many of the leaves that still remained on the trees were badly affected by rosy aphis. These aphis suck the sap from the leaf and cause it to curl in a characteristic manner. Most of these small apple trees are badly infested with oyster-shell scale. At the time of this visit the insects were still in the egg stage, but they will soon hatch and begin their work on the bark of the tree. Many of these trees which were suffering the loss

of their foliage also had their trunks badly affected by sunburn or canker and by attacks of the flat-headed apple-tree borer. With all of these troubles we can not expect the trees to thrive; it is remarkable that they are alive at all. The attention of the commissioners was also called to the condition of the cherry trees, which were dying from some fungus or bacterial disease that is working in the tops and limbs, and to an old vineyard, many of the vines of which have been killed by phylloxera. We found phylloxera to be present on some of the vines. Doubtless the present unprofitable condition of these old vines is due to the fact that phylloxera still occur in sufficient numbers to keep them in an unproductive condition.

NOTES ON CONDITIONS IN DIFFERENT ORCHARDS.

Having discussed the general conditions of the orchards in the region of Vallejo and Benicia, it may be worth while to give in some detail the notes taken in several different orchards; such will not only show the basis for my conclusions, but will give the information as to the general conditions of each of the orchards discussed. Many orchards other than those mentioned below were visited and inspected, but detailed notes in regard to them need not be given.

PLACE OF WITNESSES NOS. 1 AND 1A.

The orchard on the place of witnesses Nos. 1 and 1A was inspected on November 8, 1914. Notes made thereon follow:

The orchard on this place is in a fair state of cultivation. The pears appear to have been severely pruned to cut out the dead wood due to blight or other causes.

A few greedy scales, *Aspidiotus rapax* Comst., and a few pear tree slugs, *Caliroa cerasi* Linn., were found. San Jose scale, *Aspidiotus perniciosus* Comst., was bad on some of the trees, and doubtless is doing considerable injury.

The old trees nearest the cypress trees were nearly all dead. The tenant says that there has been no fruit on these trees for the last two years because they have been too dry.

The flat-headed borers, *Chrysobothris femorata* Fab., have entered the spots on the trunk that have been killed by blister and by canker and have worked not only in the dead part but have extended their work into the live wood.

The old plum trees in the back of the orchard are pruned so high that I could not reach the branches from the ground. The trunks are badly sunburned; in fact, these trees are now merely snags with a few short twigs toward the top. The tenant says that he does not expect fruit from them because they are too old. He has already taken some of them out. He makes no mention of smelter-smoke injury.

Some of the plum trees are black with the sooty mold that grows in the honeydew from the black scale that is abundant on the trees.

Certain pear trees that stand nearest to these black plum trees are not infested with the black scale, and the trunks and leaves are bright and clean.

The apricot trees are in much the same condition as the plum trees; that is, they are simply old snags that were pruned so high that none of the branches or leaves can be reached from the ground. The trees are pruned high, in order that the orchard may be used for raising grain.

Some of the cypress trees around this orchard were dying and are badly infested with the cypress Sphaerococcus, *Sphaerococcus cupresti* Ehrh., but the work of this insect is probably only one of the factors contributing to the death of the trees.

In the vineyard across the drive (I am not sure that this belonged to the same owner) all of the vines near the eucalyptus trees were dead. On other vines the grapevine leaf hoppers, *Typhlocyba comes* Say., were abundant, and the leaves showed plainly the effects of their work.

PLACE OF WITNESS NO. 25.

Place visited October 31, 1914.

In the old orchard south of the road I find the pear trees dropping their leaves. This is the normal autumnal dropping.

San Jose scale, *Aspidiotus perniciosus* Comst., is abundant on the trunks and limbs of the trees. This insect must be doing considerable damage.

The greedy scale, *Aspidiotus rapax* Comst., is quite abundant also, and probably doing some injury.

The black scale, *Sassita oleae* and the oyster-shell scale, *Lepidosaphes ulmi* Linn., also occur on the trees, but they are not abundant enough to be doing any injury.

The work of the pear slug, *Colisoa cerasi* Linn., is evident on many of the leaves. This work causes a browning which might very readily be mistaken for smoke injury.

The pear-leaf blister mite, *Eriophyes pyri* Pgst., is rather common in many of the leaves, causing injury that is often mistaken for smoke injury.

The codling-moth, *Cydia pomonella* Linn., larvæ and old cocoons are rather abundant under the bark of the trees. While the injury caused by this insect can not, of course, be mistaken for smoke injury, the insects seriously damage the crop, and all of these things need to be taken into consideration when estimating the amount of loss due to various causes in the orchard.

The cultivation of the orchard is only superficial, and there has been no attempt to plow close to the trees. The owner says that this orchard is no longer of any value, and he does not give it much care. He thinks that the smoke does him most damage during the summer time.

On the other side of the road, near the house, we found the raspberry bushes with many old dead leaves on them; some of the old vines showed about one-half of the leaves dead. This condition seemed to be the result of the bushes drying out. The grapevine leaf hopper, *Typhlocyba comes* Say., and two other species of hoppers were rather common on the raspberry leaves, causing white spots.

On the grape vines the leaf hoppers were abundant, causing conspicuous characteristic spottings of the leaves. This spotting is often mistaken for smoke injury.

There is considerable dead wood in the small orange trees close to the house. A few soft brown scale, *Coccus hesperidum*, Linn., were found on these trees, but there are not enough of them to be of much importance. The condition of the trees is probably due to drying out.

Five or six young navel-orange trees are badly injured by the work of the spotted flower beetle, *Diabrotica soror* Lec. This insect chews the tissues of the leaves, leaving them ragged. The soft brown scale is abundant on these trees.

On two of the small lemon trees we found a few black scale and a few of the soft brown scales.

The work of the peach-twig borer, *Anarsia lineatella* Zell., is conspicuous on the peach trees. The tips of the twigs and many of the lateral shoots have been killed. This injury is commonly supposed to be due to smelter smoke. The larvæ are now hibernating in little cells in the crotches of the trees.

The injury due to the work of the two-spotted mite, *Tetranychus bimaculatus* Harv., is rather conspicuous on the plum tree near the house. The leaves are rather spotted

and whitened. Some aphis, species undetermined, is causing the leaves to curl. A slug, probably a pear-tree slug, has also been at work on the plum trees.

The two-spotted mite is abundant on the watermelon vines, causing the leaves to turn brown, an injury that is usually ascribed to smelter smoke. The small green leaf hopper is also abundant on these vines. The black-spotted flower beetle, *Diabrotica soror* Lec., is also rather common on these vines, and is doing its part to destroy the foliage.

On the muskmelon vines the red-banded thrips, *Heliothrips fasciata* Pergande, are doing a good deal of damage. The browning of the leaves due to their work is conspicuous. The leaf hoppers are also bad on these vines.

The squash vines are also badly infested with the same thrips and leaf hoppers. Special attention should be called to the work of these insects on such vines as these and on other garden truck. These insects are so small that they usually escape the notice of the gardener, and as their work causes the leaves to turn pale, and often to turn brown in spots, practically all of the gardeners in all smelter regions believe that the injury caused by these insects is due to smelter smoke.

PLACE OF WITNESS NO. 34.

Inspection made October 31, 1914.

The orchards on this place have evidently been abandoned and are now being used for pasture. Many dead trees were found throughout the orchard, and the other trees are badly sunburned, broken, and infested with various kinds of insects, but the whole orchard is in such a condition that it would not be worth while to try to make any estimate of the amount of injury there.

CARQUINEZ CEMETERY.

Inspection made October 31, 1913.

Many of the Monterey cypress trees in this cemetery were dying. On the trees near the road that have been pruned for a hedge, I found a scale insect, *Sphaerococcus cupressi* Ehrh., abundant. This scale works on the trunk and branches of the tree and hides itself in the cracks and crevices as much as possible. The white, flocculent secretion that covers the insect and fills the crevices in which it is hiding makes it rather conspicuous, particularly if pieces of the old, rough bark are torn away. This insect is doubtless doing a great deal of damage to these trees, and I was at first inclined to ascribe the condition of the trees to its attacks. Upon examining other trees, however, I found many dying that were not badly infested with this scale insect, and, as later notes will show, I found the same insect common on cypress trees in the Benicia cemetery, where few of the trees were dying.

In some of the dying cypress trees I found a few bark-boring beetles at work, but as these insects seldom attack the cypress trees until they are weakened from other causes, I do not hold them entirely responsible for the condition of the trees.

My final conclusions in regard to these insects were that they are only one of the factors that are concerned in the killing of these trees.

GLEN COVE.

Inspection made October 31, 1913.

Some of the apple trees on this place are old and gnarled and badly affected by various insects. Some large wood borer has been working in the bark and wood of some of the trees, doing a great deal of damage. Nearly all of the trees are badly infested with oyster-shell scale, *Lepidosaphes ulmi* Linn.; many of the leaves are curled by aphis, *Aphis sorbi* Kalb.; red spiders, *Bryobia pratensis* Garman, are abundant on some, and much of the foliage is affected by apple mildew. A few leaf hoppers were also found on some of the trees.

On the almond trees I found many red spiders, *Bryobia pratensis* Garman. The old and young were still active, and there were many eggs on the lower sides of the branches. A few scale insects were also found on these trees.

PLACE OF WITNESS NO. 5.

Inspection made October 31, 1913.

The old almond trees have already lost most of their leaves. Those that remain are still infested with the mites, *Bryobia pratensis* Garman. On the under side of the twigs and smaller limbs I find an abundance of mite eggs.

The black scale, *Saisseta oleae* Bern., is also abundant on many of these trees. The trees themselves are black, being covered with a sooty mold which grows in the honeydew secreted by the infesting scale insects and aphis. This condition is, as I have pointed out in other parts of my report, commonly ascribed to smelter smoke. I have often called attention to the fact that only the trees that are affected with aphis or certain kinds of scale insects are blackened in this way. Other near-by trees, which are free from these insects, do not show this blackened condition.

In this same orchard the pear trees, fig trees, and others that are seldom seriously attacked by aphis or by *Lecaniums* are quite free from this black, sooty mold.

Many of the plum trees are black on account of the presence of this sooty mold. On such trees the black scale is abundant, and they were probably badly infested with aphis earlier in the season. The two-spotted mites, *Tetranychus bimaculatus* Harv., are abundant on these leaves. Not only do these mites do considerable damage to the leaves, but the fine webs that they spin for the protection of their eggs and young help to hold the sooty mold on the leaves, thus making them look worse.

Many of the almond trees on the hill are badly infested with black scale, and the black mold on the trees is growing in the secretion from these insects. The under sides of some of the limbs of these trees show large masses of eggs of the red spider, *Bryobia pratensis* Garman.

The apricot trees on the hill near the barn are in good condition. The leaves are beginning to fall. I found a few of the two-spotted mites on some of the leaves.

The grapevines have had practically all of the leaves stripped from them by the sheep that have been feeding in the vineyard.

PLACE OF WITNESS NO. 8.

Inspection made November 8, 1913.

The young apple trees on this ranch are in bad condition on account of the work of the woolly aphis, *Schizoneura lanigera* Hausm. I have never before seen trees so badly infested by this insect as these are. The roots, trunks, and branches of many of them are almost covered with these pests and many of the roots and branches are badly swollen and knotted. Trees in such condition can not be expected to flourish. Many of these same trees are also badly infested with the rosy aphis, *Aphis sorbi* Kalt.

The apricot and peach trees are in fairly good condition.

The almonds look well except for the work of the mites, *Bryobia pratensis* Garman. These have made the leaves look pale. Some of these trees show considerable gummosis, and a few black scales were found on others.

The plum trees seem to be in fairly good condition except for the work of the aphis *Hyalopterus arundinis* Fab., which have curled some of the leaves and secreted a considerable amount of honeydew, in which the black, sooty mold is developing. This is, of course, responsible for the black condition of these trees.

The pear trees seem to be in good condition and free from insect pests.

The vineyard is in very good condition except for the vine leaf hoppers, *Typhlocyba comes* Say.

The red spiders, *Bryobia pratensis* Garman, have spotted some of the leaves on the quince, but these are not bad.

A few red spiders were also found on the cherry trees.

The young orange trees near the house are practically black from the sooty mold that is growing in the honeydew secreted by the black and soft brown scales that are abundant on these trees.

The berry vines show much spotting on the leaves, due to the work of the grapevine leaf hopper.

PLACE OF WITNESS NO. 23.

Inspection made November 8, 1913.

In the young orchard the cherry trees are fine, bright, and clean. Only a few red spiders were found on them.

The peach trees are in good condition. A few twig borers, *Anarsia lineatella* Zell., were found on them, and these will, of course, kill some of the new shoots next spring. Few red spiders were found on these trees.

On the old pear trees a considerable number of greedy scales, *Aspidiotus rapex* Comst., and a few black scales were found. There were enough of the latter to cause some blackening of the tree.

The old plum trees were badly infested with red spiders and black scale, and so, of course, were quite black.

The apple trees are in good condition, except that the leaves are whitened by the work of the red spider and a small leaf hopper. Some woolly aphis and rosy aphis were also found on these trees.

The old pear trees in the back yard are no longer cared for and are used for chicken roosts. The blister mite, *Eriophes pyri* Pgst., was bad on some of them.

PLACE OF WITNESS NO. 4.

Inspection made November 1, 1913.

The old orchard back of the house, consisting of 24 trees of various kinds, has evidently been abandoned, and is now used as a pasture for horses, cattle, and sheep.

The trees are badly broken and scarred and many of them are badly gnawed by the stock.

The apple trees are literally covered with oyster-shell scale, *Lepidosophes ulmi* Linn., and woolly aphis, *Schizonema lanigera* Hausm.

The pear trees have a good deal of black scale and greedy scale, *Aspidiotus rapex* Comst., on them. Mr. Brazil stated that the pears and apples are full of worms, a condition that we would expect.

The orchard is of no commercial value in its present condition, and no estimate could be made of the amount of damage due to any cause.

PLACE OF WITNESS NO. 12.

Inspection made November 8, 1913.

The almond trees along the roadside are in fine shape. They are clean and almost free from red spiders and black scale.

The peach trees, too, are clean and bright, but there are few of the peach-twig borers, *Anarsia lineatella* Zell., in them.

The plum trees at the upper end of the orchard have considerable black scale; hence they are black from the sooty mold. The aphis, *Hyalopterus arundinis* Fab., and the two-spotted mite, *Tetranychus fimaculatus* Harv., are still rather abundant on some of these plum trees.

The apple trees have a few woolly aphis, rosy aphis, and oyster-shell scales, but they are doing no appreciable injury.

The apricot trees are in good condition.

The small orange trees are badly infested with brown scale; hence the leaves, trunks, and limbs are badly affected with the black, sooty mold.

The grapevines are in fine condition, except for the work of the grapevine leaf hoppers.

On the whole, this little orchard and vineyard is in as good condition as one would find anywhere in the State, and I have often called attention to it as an example of what one is able to do in this section if the proper care is given to the orchard.

PLACE OF WITNESS NO. 32.

Inspection made November 14, 1913.

The small grove of orange trees on this place is in bad condition. Nine of the trees show little green wood and the rest of them are in little better condition. Those nearest the house are in the best condition. The tenant explained this by pointing out that the house was between these trees and the point from which the smelter smoke usually came. This was considered strong evidence that the smelter smoke was responsible for the death of the other trees, but the fact should be noted that these same green trees are the ones that have received some water, while the others have evidently received none. A pipe was used to lead the water some distance from the tank house, and the water was then carried in small ditches to these green trees. Some of the trees have also been dug around. There is nothing to indicate that the nine or ten trees that are in worse condition have received any water or cultivation. I find that roots of considerable size have come near to the surface of the ground, many of them being within 5 or 6 inches. This shows that there has been no recent cultivation.

All of the trees show about the same amount of black scale, *Saisseta oleae* Bern., brown scale, *Lecanium corni* Bouche, and cottony cushion scale, *Icerya purchasi* Mask., and all are equally black as a result of the sooty mold. The scale insects are not abundant enough to account for the poor condition of the trees.

The thrifty condition of the young trees in Corcoran's yard just across the road, which have absolutely no protection from the smelter smoke should it come in from the direction indicated, leads one to believe that the condition of the trees in this orchard can be due to nothing but neglect.

The lemon trees look little better than the orange trees, and the conditions surrounding them are about the same.

The pomegranate trees have some black scale and a few cottony cushion scales, and consequently show some of the black, sooty mold.

The rose bushes and other ornamental plants in the front yard are now being pruned. The amount of old wood that is being removed shows that this is the first pruning they have had for some years.

Four grapevines that are climbing over the exposed side of the house—that is, the side toward the gap in the hills through which the smelter smoke is said to come, are in good condition and still have some grapes on them.

The olive trees have some fruit on them, but they are quite black with the sooty mold, which is due to the presence of black scale.

Scale insects are also very abundant on the holly trees. These trees are, therefore, very black with the sooty mold.

The old vines in the small vineyard are almost leafless now. The remaining leaves show that there have been some leaf hoppers at work on them. These vines have been cultivated and seem to be in good condition.

The old apple trees are badly infested with San Jose scale, *Aspidiotus perniciosus* Comst., and oyster-shell scale, *Lepidosaphes ulmi* Linn. I have seen no other trees in this region so badly infested with these insects. There are also some rosy aphis, *Aphis sorbi* Kalt., and woolly aphis, *Schizoneura lanigera* Hausm., on these trees.

The plum trees are black on account of the presence of black scale and aphis.

PLACE OF WITNESSES NOS. 65 AND 75.

Inspection made November 14, 1913.

The place is situated on the west edge of Benicia.

A few old almond trees in this yard are uncared for and in bad condition. Some of them are quite black with the sooty mold that grows in the secretion from the aphis and scale insects. Witness No. 75 is sure that this black condition is due to smelter smoke. She says that it is over the stubble and everything else in the summer. She says that it is worse here in July and August.

The few fig trees in the orchard are also neglected and in bad condition.

PLACE OF WITNESS NO. 69.

Inspection made November 7, 1913.

The place is situated in West Benicia along the Vallejo Road.

The peach trees in this yard look fine and thrifty. No insects were found on them.

The apple trees too are looking fine. Only a few aphis were found on them.

The plum and pear trees also are in good condition.

This little orchard is well tilled and seemingly well cared for.

In the vineyard on the hill I found several places where the vines have made little growth this year. Others near them appear to be in good shape. This condition is probably due to either phylloxera, *Phylloxera vastatrix* Planchon, or to differences in the character of the soil. I dug around the roots somewhat and found no phylloxera, although closer search during the summer time might have revealed them. It is rather likely, however, that the condition of the vines in these spots is due to the differences in the soil conditions.

The leaf hoppers, *Typhlocyba comes* Say., are abundant in this vineyard and have done considerable damage this year.

PLACE OF WITNESS NO. 46.

Inspection made November 1, 1913.

The place is situated in West Benicia.

The apple trees in this yard are in very bad condition, due to the woolly aphis, *Schizoneura lanigera* Hausm., on the roots, trunks, and branches. The rosy aphis, *Aphis sorbi* Kalt., is also abundant on the leaves.

The pear trees still have a few leaves left on them and these are badly infested with the two-spotted mite, *Tetranychus bimaculatus* Harv.

The plum trees are also badly infested with the two-spotted mite and some black scale. These trees show a considerable amount of the black sooty mold. Some of these trees were injured by having a band of tar painted around the trunk about four years ago. The injury due to this treatment is still evident.

The peach trees have a considerable number of two-spotted mites on them.

The grapevines show conspicuously the work of the leaf hoppers, *Typhlocyba comes* Say.

The apricot trees appear to be in good condition. They have only a few scale insects, *Lecanium corni* Bouche, on them.

The leaves of the big blue plum tree are nearly all gone now. Those that remain show an abundance of two-spotted mites.

On this date the first rain of the season began.

PLACE OF WITNESS NO. 135.

Inspection made November 7, 1913.

The place is situated in Benicia one block east of the Benicia-Vallejo road.

Near the house there are about 150 grapevines, which we would estimate to be about 4 years old. These show many dying leaves, which are probably dying on account of the lateness of the season. A few grapevine leaf hoppers, *Typhlocyba comes* Say., were found on these vines.

The peach trees, which are 2 to 4 years old, are in good condition. No insects were found on them.

The one small plum tree showed many red spiders, *Tetranychus bimaculatus* Harv., and a few aphis *Hyalopterus arundinis* Fab.

The small lemon tree and the three small orange trees showed many cottony cushion scales, *Icerya purchasi* Mask., and soft brown scales, *C. hesperidum* Linn.

PLACE OF WITNESS NO. 9.

Inspection made November 7, 1913.

The old pear trees on this place are in bad condition. Some of them have large limbs that have been killed by a borer that has girdled the limbs and then entered the hardwood. The work looks something like that of the carpenter worm, but I am not sure what insect it is that has been doing the work.

A few blister mites, *Eriophes pyri* Pgst., and greedy scales, *Aspidiotus rapax* Comst., were found on these trees.

The apricot trees are badly infested with black scale, *Saisseta oleae* Bern., and hence are badly covered with the black sooty mold.

The apple trees are very badly infested with oyster-shell scale, *Lepidosaphes ulmi* Linn. This insect is probably in a large measure responsible for the condition of these trees. Rosy aphis, *Aphis sorbi* Kalb., and woolly aphis, *Schizonema lanigera* Hausm., are also bad on these trees.

The almond trees are badly infested with black scale and have much of the black sooty mold on them. Red spiders, *Bryobia pratensis* Gar., are very abundant on the almond trees.

The grapevines have been badly injured by leaf hoppers, *Typhlocyba comes* Say. which are still abundant on them.

PLACE OF WITNESS NO. 10.

Inspection made November 7, 1913.

Witness No. 10A says that the vineyard by the house is the oldest one in Benicia. They have given this vineyard good care during the four years they have been on the place, and she says they have always had a good crop of grapes.

She says that the trees in the yard have also yielded them good crops, because they have cared for them.

She says that the smelter smoke is sometimes strong enough to make her cough, but she does not think they have had any injury to the vegetation since they have lived there.

PLACE OF WITNESS NO. 24.

Inspection made November 15, 1913.

Witness No. 24A believes that her place has been badly injured during the past few years by the smelter smoke; practically nothing has escaped injury from it; the grapevines, fig trees, roses and other ornamental plants, all of the orchard trees, the wire fences and screens, and even the chickens and live stock, she believes, have been injured.

She showed me the remains of a chicken gizzard and liver that she says were perfectly black when the chicken was killed.

The lemon tree in front of the house is in fairly good condition. It has some soft brown scale, *Coccus hesperidum* Linn., and some cottony cushion scale, *Icerya purchasi*

Mask., on it. She says that she watches this tree carefully to keep the insects off and to keep it clean.

Two small orange trees in front of the house are very badly infested with soft brown scale and the leaves and trunks are covered with the black sooty mold. Witness No. 24A believes that this sooty mold is due to the smelter smoke.

The loquot trees are now blooming and in very good condition.

The peach trees are badly infested with black scale, *Saisseta oleae* Bern.; hence they are blackened with the sooty mold. The branches and some of the leaves are well covered with this black mold. Witness No. 24A says that the fruit was quite black last summer. She believes that smelter smoke was responsible for this condition.

The black sooty mold was probably growing on the fruit as well as on the leaves and branches.

Some of the brown apricot scales, *Lecanium corni* Bouche, were also present on the peach trees.

The plum trees were badly infested with black scale, and so were covered with the black sooty mold.

The south, or exposed, sides of the trees are badly sunburned and the wood thus injured is now infested with flat-headed borers, *Chrysobothris femorata* Fab.

The apricot trees are badly infested with black scale and show considerable black sooty mold on the leaves and branches of the trees.

The south sides of the trunks of the cherry trees are in bad condition. Most of these trees show considerable gummosis. Many of the upper twigs are dying.

The trunks of the apple trees are badly sunburned on the exposed side, and flat-headed borers are working in these affected places. Some woolly aphis, *Schizoneura lanigera* Hausm., and oystershell scales, *Lepidosaphes ulmi* Linn., were found. The latter are bad on some of the trees. Some of the leaves that remain on the trees are also affected by rosy aphis, *Aphis sorbi* Kalb.

In other parts of the report I have discussed the experiments that were made in this orchard to try to control some of these pests.

The old vineyard north of the house is in bad condition. It has not been cared for for some years because it has been unproductive. The vines in this old vineyard are dead in spots. The vineyard looks very much as though it had been affected some years ago by phylloxera, *Phylloxera vastatrix* Planchon. These insects gain a foothold in certain parts of the vineyard, sometimes entirely killing the affected vines, and at other times weakening them to such an extent that, although they may still remain alive, they are unproductive. The insects gradually spread through the vineyard and often affect all of the vines.

The younger vineyard west of the old one is in better condition, but the vines in the lower part of this vineyard are also dying. I tried to dig around these vines in order that I might examine the roots, but the ground was so hard that I could not dig more than 6 inches with a shovel. In this distance I found no small rootlets.

On January 9, 1914, after we had had a good deal of rain, I again dug around these grapevines in the young vineyard. I selected two vines that showed a little growth last year. No small roots were found on these vines and the large ones were mostly dead. I selected a vine in the old vineyard that showed as much growth as any near by, and no small roots were found on this vine, although we dug considerably more than 2 feet deep. The larger roots were nearly dead here also and although we found no root borers there was considerable evidence that these insects had been at work on the roots. On the roots of other vines in this vineyard we found a number of phylloxera.

The condition of the roots and the finding of these insects justifies my conclusions that the vineyard has been seriously affected by the phylloxera.

PLACE OF WITNESS NO. 26.

Inspection made November 21, 1913.

The olive trees on the hill back of this place are badly infested with black scale, *Saisseta oleae* Bern.; hence they are black with sooty mold. The trees are low, bushy, and not well cared for. There is little or no fruit on them.

The pear trees and the plum trees near the house are badly infested with European pear scale, *Epidiaspis pyricola* Del Guercio. Some of the trees in this orchard are dead and they were probably killed by this scale insect.

On February 14, 1914, I sprayed two plum trees and two pear trees in this orchard with distillate emulsion, using 1 part of the emulsion to 16 parts of water.

A later examination showed that although many of the scale insects had been killed, others were so well protected in the crevices of the bark that they had escaped the action of the spray material.

AGRONOMIC AND SOIL CONDITIONS IN THE SELBY SMOKE ZONE.

By Charles F. Shaw and E. E. Free.

INTRODUCTION.

In accordance with the instructions of the commission, we have made a study of soil conditions in the area under examination by the commission, the results of which study we report herewith.

In our letter of December 1, 1913, to the commission, we stated that in our opinion two separate problems were involved in the agronomic inquiry, namely:

1. Has the damage, or any part of the damage, claimed been due to some soil trouble not connected with the smelter?

2. Has there been any actual pollution of the soil of the area by materials from the smelter?

In the same letter we recommended the appointment of an assistant who should observe weekly the agronomic conditions in the region and report the occurrence and nature of any evidence indicating soil trouble or other circumstances injurious to the growing crops. We also recommended the analysis of a series of soil samples for elements, the presence of which would indicate soil pollution by smelter materials. Both recommendations having been approved by the commission, the investigations mentioned have been carried out and the results are reported herewith. The weekly examination of the region was made by Mr. Ralph W. Brown, whose detailed report appears herewith. The chemical analyses for the determination of soil pollution have been made by Mr. C. E. Brandt under our supervision.

AGRONOMIC CONDITIONS.

The soils of the region are loams or silt loams derived from the weathering of sandstones and shales extensively exposed in the region. There is little or no river silt or other soil material transported from a distance. The topography is between what would be called rolling and what might be called mountainous. Low but fairly steep hills alternate with narrow valleys, the lowest parts of which are frequently occupied by arms of the bay or by flat flood plains which were once estuaries and have been filled with alluvium.

The soils of the hillsides and hilltops are residual in origin and usually rather thin with frequent exposures of the underlying rock. Even in the valleys the soils are not deep, but are underlain at 2 to 4 feet by impervious clays. Humus is usually deficient even in the valleys, and is almost always so in the soils of the uplands.

The soils can not be regarded as of high quality. Their local origin from sedimentary rocks makes for lack of diversity in their mineral constituents and for poverty in plant-food materials. The low humus content, though perhaps in part susceptible to improvement by proper culture, is nevertheless a serious detrimental factor at present.

The chief disadvantage of the soils is their lack of depth. This decreases their capacity for water storage and for the supply of plant food materials to roots and, in connection with the steepness of the hillsides and the broken topography, renders proper cultivation and the accumulation of humus difficult.

No evidences of alkali or bad drainage have been observed except on the tidal flats in the lowest parts of the valleys, these flats being of small area and not under cultivation.

The agriculture of the region is largely the raising of grain (wheat, oats, and barley), much of which is cut for hay. Much land is pastured or used for volunteer hay. There are a few orchards, vineyards, and vegetable gardens, but all are small and unimportant to a general survey. Cultivation methods and agricultural practices in general are careless and not well thought out. The preparation of the seed bed does not receive proper attention; seeding is imperfect and irregular; no care is taken to eliminate weeds; and in general small use is made of the practices of modern agriculture. Especially is this true of practices assisting the conservation of soil moisture. There can be little doubt that on most of the soils of the area it is lack of water that limits production. The annual rainfall is only 15 to 20 inches and is not distributed satisfactorily through the year. The natural water-storage capacity of the soils is low. Accordingly the first essential of a proper agricultural practice for the region would be the effort to retain and conserve for crop use the largest possible proportion of the rainfall. Cultivation for increased absorptiveness, the increase of humus to improve capillary retention of water, the use of the soil mulch to prevent loss by evaporation; these and similar well-known procedures should be the backbone of the agricultural régime. We have not found them. So far as we can learn, this very important matter of water conservation has been entirely neglected by the farmers of the region.

The first question that our inquiry was intended to cover is noted above as the possibility of the damage claimed having been due to

some soil trouble. Excluding injuries affecting persons or domestic animals, the damage claimed is of two classes:

1. The so-called "visible" damage or "burning" of useful plants by gases or other poisonous materials from the smelter.

2. The "invisible" damage, a general detrimental effect on the amount and quality of the crop without the production of any definite injury of the "visible" class.

"Visible" damage is quite characteristic and is most unlikely to be confused with any effect of soil deficiency or other general trouble. Whether or not damage of this class occurs in the area examined is a matter outside the scope of our inquiry and to which we have given no attention. We are not acquainted with any soil-caused condition of plant unhealth which could possibly be mistaken for smelter injury of the visible class.

The existence of "invisible" damage in the region has been claimed on the ground of poor crop yield, unhealthful condition of trees, and the like. We have been unable to procure any satisfactory quantitative data of average yield, but it is beyond question that yields are below what would be expected for the climate of the region. This might be due to one or more of three causes: (1) Poor soil; (2) poor agricultural practices; (3) some definite unfavorable factor, such as damage by the smelter. In our opinion there is no doubt that the first two are operative and are adequate to explain the existing bad conditions. The soil is not good and the agricultural practices are such as to emphasize rather than to cure the natural soil defects. So far as we can judge from the experience of this year the crops have been at least as good as could be expected and there is no evidence of any "invisible" damage unaccounted for by soil and cultural deficiencies. Similarly in orchards and vineyards the unhealthful conditions that undoubtedly do prevail can be ascribed entirely to lack of intelligent pruning and cultivation, failure to provide against the inroads of insects and disease, and similar matters which may be summed up as lack of care. We have found no orchard trouble that can not be accounted for as due to this or to a naturally poor situation with regard to topography or soil.

It should be noted, however, that the past year has been unusually favorable as regards temperature and rainfall, and it is possible that injuries that appeared in previous years have not persisted or reappeared in this. We can say nothing as to this, and we do not attempt a final conclusion that damage by the smelter has not occurred, even in this year. All that we can say is that the poor agricultural conditions observed by us during the past fall, winter, and spring are amply accounted for by the naturally unfavorable soil and the extremely poor agricultural practice of the region.

SOIL POLLUTION.

The second problem presented us was that of discovering whether the material discharged by the smelter had contaminated the soils of the area under examination. The materials discharged are mainly of two classes: (1) Gases and condensable vapors, mainly the oxides of sulphur; (2) solid flue dust, consisting of compounds of lead, arsenic, and other elements.

Injurious soil contamination by materials of the first class is scarcely possible. In contact with water or moist materials the sulphur gases form either sulphurous acid or sulphuric acid, both of which would combine immediately with the hydroxides and carbonates always present in the soil, forming sulphites or sulphates of calcium, iron, magnesium, etc. Under soil conditions any sulphites so formed would not persist, but would be changed very rapidly to sulphates, which are normal soil constituents. In most soils calcium carbonate is the base, present in largest amount, and with which the sulphur acids would thus combine, the final result being calcium sulphate or gypsum.

Gypsum is somewhat more soluble in water than is calcium carbonate, and it is conceivable that the application of large amounts of sulphur gases to a soil naturally poor in lime might convert all of the lime into gypsum and thus increase leaching to an extent that would leave the soil really deficient in the essential lime salts. Indeed, actual cases of such injury have been reported from Germany.[a] In the present case such injury would seem improbable because of the distance of the smelter from the soils in question, but to make this conclusion certain, nine of the soil samples collected for the lead and arsenic determinations below described have also been analyzed for their content of calcium carbonate, with results as given in Table 1. The locations from which the samples were taken are given in a subsequent section of this report.

TABLE 1.—*Results of determinations of calcium carbonate in certain soils.*

Sample No.	Calcium carbonate.	Sample No.	Calcium carbonate.
	Per cent.		*Per cent.*
102	0.29	1302	0.16
302	.11	1402	.09
502	.18	1602	1.53
902	.04	2302	.10
1202	2.22		

The amounts of calcium carbonate found are as large as is normal for soils of the type and region, and calcium carbonate is present in all of the samples examined. This is really the important point, since damage by sulphur gases in the manner described would result in the removal of all the calcium carbonate by its transformation

[a] Weiler, A., (The removal of lime from soils through smelter smoke): Wiener landw. Ztg., vol. 63, 1913, p. 135; Eicke, (Damage from smoke in the Rhenish-Westphalian district): Rauch und Staub, vol. 3, 1913, pp. 162-167.

into gypsum. We may conclude that there has been no important damage to the soil by sulphur gases. Of course, this refers only to damage to the soil itself. Possible injury directly to the plant by sulphur gases in the atmosphere does not come within the scope of our investigation.

To discover whether there has been contamination of the second sort; that is, by flue dust, we have resorted to the determination of arsenic and lead in the soils. Except the sulphur acids, these are the only major constituents of the smoke that could be expected to have any poisonous action on plants; they are normal soil constituents only in traces, if at all; and lead is the chief metallic element in the fume and flue dust from the Selby smelter. These elements are well adapted therefore to serve as indicators not only of a soil pollution that might be agriculturally dangerous, but also of any lesser degree of contamination that, though not agriculturally injurious, would indicate the addition of smelter emanations to the soils of the area.

For the determination of these elements, soil samples were taken by A. E. Wells and E. E. Free at 24 locations, as shown in the list on page 413, and on Plate XXXVIII. (In pocket). At each station two samples were taken; one of the surface half inch of the soil, the other, a normal soil sample taken in the usual manner to a depth of 10 or 12 inches. In all cases included rootlets were taken with the sample. The samples were taken between November 10 and 17, 1913, before the commencement of the winter rains, and thus included all dust accumulated during the summer but which might be removed by winter leaching. A slight shower fell previous to the collection of samples from stations 16 to 24, inclusive, but was scarcely sufficient to wet the surface and can have had no leaching effect.

The analytical methods employed in the examination of these samples have been worked out especially for this investigation. Arsenic had frequently been determined in soil by previous investigations and several methods have been described.[a] All are extremely complicated and laborious. Being desirous rather of discovering quickly the general indications offered by the arsenic content of the soils than of attempting perfect accuracy in the determination, we abandoned the complex methods of the literature in favor of a simple and rapid method, which may be outlined as follows:

A weighed sample of the well-mixed, dried soil was digested with sulphuric acid for several hours and soil and acid were then washed

[a] Gautier, A., Sur le dosage de l'arsenic, Compt. rend., vol. 122, 1896, pp. 426–427; Haywood, J. K., Injury to vegetation by smelter fumes, U. S. Bureau of Chem., Dept. of Agri., Bull. 113, 1908, p. 35; Mai, C., Nachweis und Bestimmung von arsen in Friedhoferde, Pharm. Zentralb., vol. 50, 1909, pp. 169–200; Headden, W. P., The occurrence of arsenic in soils, plants, and animals; Proc. Colo. Sci. Soc., vol. 9, 1910, p. 348; Bressanin, G., Methode de recherche, de séparation et determination de l'arsenic et de l'antimoine, Ann. chim. anal. vol. 17, 1912, pp. 81–84; Zuccàri, G., Ricerca e determinazione dell'arsenico nella terra di un cimitero, Gaz. chim. ital., vol. 42, pt. 2, 1912, pp. 633–638; Greaves, J. E., Some factors influencing the quantitative determination of arsenic in soils, Jour. Am. Chem. Soc., vol. 35. 1913, pp. 150–156.

into a Marsh generator of the usual type. The arsenic was collected as a mirror in a hard-glass tube in the usual manner and determined by comparison with standard mirrors produced by known quantities of arsenic. Care was taken to use reagents entirely free from arsenic and to make all mirrors under the same conditions of operation in all particulars. Comparative tests, tests on known materials, and the like showed this method sufficiently accurate for the purposes of this investigation.

The determination of lead was much more difficult. No method had been developed for small traces of lead in soil. The usual metallurgical methods are obviously inapplicable and the colorimetric methods employed in water analysis can not be applied in the presence of the complex and highly colored soil solutions. After much experimenting the following method was adopted:

Five hundred to 1,000 grams of the dry soil was digested, first with nitric acid, then with acetic acid and ammonium acetate. The double digestion is for the purpose of dissolving lead present either as metal, as sulphide, or as sulphate. After each digestion the soil was washed with water by decantation and on a filter. To the filtrate from the nitric acid digestion, potassium bichromate was added. The lead precipitated as lead chromate but in an impure condition. To purify it, the precipitate was dissolved in nitric acid and reprecipitated as lead sulphate by the addition of a little sulphuric acid. This precipitate of lead sulphate was dissolved in acetic acid and ammonium acetate and the lead precipitated with hydrogen sulphide, the sulphide being then dissolved in nitric acid and reprecipitated as lead sulphate. Usually it was necessary to repeat twice or more the purification by successive precipitation with hydrogen sulphide and sulphuric acid.

With the filtrate from the acetic acid digestion, the precipitation with potassium bichromate was omitted. The filtrate was treated directly with hydrogen sulphide and the precipitate purified by reprecipitation as sulphide and sulphate in the same manner as the precipitate from the nitric acid digestion. Both precipitates were finally weighed (separately or together) as lead sulphate.

The analytical results on the samples are given in Table 2. For convenience in the study of the table the soils are arranged in three groups according to location: (1) Those from the immediate water front and the sides of the hills facing the smelter, where full exposure to fume contamination would be found, if anywhere in the area; (2) those from behind the first range of hills, not directly exposed to winds from the smelter, and the exposure of which to fume contamination is possible but not certain; (3) those from beyond Sulphur Springs Mountain and from similar distant places where the smelter fume could scarcely be expected to reach in much quantity, if at all.

TABLE 2.—*Results of determinations of arsenic and lead in soil.*

[Parts per one million parts of dry soil.]

Character of samples.	Station No.	Arsenic or lead in surface half inch of soil.		Arsenic or lead in upper 10 inches of soil.	
		Arsenic.	Lead.	Arsenic.	Lead.
Exposed to fume contamination	1	2.0	21.5	3.0	5.4
	3	18.0	13.5	36.0	1.6
	4	30.0	11.5	.....	.....
	8	12.0	4.8	10.0	3.6
	9	16.0	5.9	6.0	4.9
	12	6.0	6.1	6.0	6.0
	13	5.5	12.9	16.0	4.2
	23	50.0	22.0	30.0	3.0
Exposure doubtful	2	2.0	7.1	8.0	3.4
	5	.....	.....	.4	2.4
	6	.....	.....	9.0	1.5
	7	.....	None.	10.0	None.
	10	.....	.....	20.0	4.8
	14	.....	.....	5.0	5.1
	15	.....	.....	40.0	None.
	24	.....	.....	12.0	6.4
Not exposed	11	8.0	10.5	3.6	6.8
	16	.4	2.2	6.0	.5
	17	.....	.9	4.0	None.
	18	.....	None.	8.0	.5
	19	.2	.3	7.0	4.9
	20	7.0	4.3	7.0	5.7
	21	.....	1.0	6.0	4.3
	22	.....	None.	4.0	6.8

Referring first to the arsenic determination, it is seen that this element was found in every soil examined, without exception. The quantities found in the more exposed soils are somewhat larger than in those of the less exposed groups, but the difference is not great and is no larger than the differences between samples of the same group. It is apparent that arsenic is a normal constituent of the soils of the region and that no conclusion concerning fume contamination can be drawn from the arsenic determination. This general presence of arsenic is quite in accord with the results of previous investigators. Small quantities of arsenic are of frequent occurrence in soil.[a] It has been found in many rocks, mineral springs and volcanic emanations, and in sea water. Clarke and Steiger[b] found it in composite samples of clay from the sea bottom of Mississippi River silt, and of igneous rocks from all parts of the United States. Few elements are more widely distributed.

[a] Orfila, —, Encore un empoisonnement par l'arsenic: Jour. chim. méd., vol. 5, ser. 2, 1839, p. 566; Becker, H., Ueber den Arsengehalt des angeschwemmten Landes in der Nähe des Wesergebirges: Archiv. Pharm., vol. 57, ser. 2, 1849, p. 129; Campbell, Dugald, On the presence of arsenic and antimony in the sources and beds of streams and rivers: Chem. News, vol. 3, 1861, p. 212; Sonnenschein, F. L., Ueber die Verbreitung des Arsens in der Natur: Archiv Pharm., vol. 143, ser. 2, 1870, p. 245; Schlagdenhauffen, —, and Garnier, —, L'arsenic du sol des cimitieres, au point de vue toxicologique: Compt. rend., vol. 100, 1885, p. 1388; Widtsoe, J. A., The relation of smelter smoke to Utah agriculture: Utah Agri. Exp. Sta. Bull. 88, 1903, p. 163; Gautier, A., Localisation de arsenic normal chez les animaux et les plantes, ses origenes: Bull. soc. chim. France, vol. 29, ser. 3, 1903, pp. 31-35; Headdon, W. P., The occurrence of arsenic in soils, plants, fruits, and animals: Proc. Colorado Sci. Soc., vol. 9, 1910, pp. 345-360; Greaves, J. E., The occurrence of arsenic in soils: Biochem. Bull. 2, 1913, pp. 519-523; Zuccàri, G., Sulla presenza dell' arsenico come elemento normale nelle terre: Gaz. chim. ital., vol. 43, 1913, pp. 398-403.

[b] Clarke, F. W., and Steiger, George, The relative abundance of several metallic elements: Jour. Wash. Acad. Sci., vol. 4, 1914, pp. 58-62.

Although this normal presence of arsenic in the soils renders it impossible to trace the arsenic found definitely to the smelter, it does not follow that no arsenic has been received therefrom. It is possible that the arsenic originally in the soil has been increased by a supply from the fume, but such supply, if any, has not been large, else the soils would contain much larger amounts than they do and the more exposed soils would carry substantially greater arsenic contents than those of lesser exposure. The amounts found are not larger than might naturally occur in the soil.

Turning to the lead determination, it is immediately apparent that this element is so frequently present as to strongly suggest that it also is a normal constituent of the soils. It was found even in samples from stations 19 and 20 miles away from the supposed zone of smelter influence. Unlike arsenic, lead has not previously been known to be a normal soil constituent, except in the neighborhood of metalliferous deposits. However, lead accompanied arsenic and other elements in the composite samples of deep-sea clay, river silt, and igneous rocks examined by Clarke and Steiger and noted above. It has been found in several samples of atmospheric dust [a] and in a number of rocks [b] and mineral springs,[c] as well as in the products of several volcanic eruptions.[d] It is not known to be so widely distributed as arsenic, but this may be due to failure to search for it and to the greater difficulty of its detection rather than to its absence.

Under the circumstances, possible error of the analytical results becomes important and requires discussion. Such error might consist in either (1) the mistaking of some other element for lead; (2) contamination of the sample with lead from utensils, impure reagents, or laboratory dust; (3) inaccuracy of results, due to loss of lead or to imperfect purification of the final lead sulphate precipitate.

To guard against the first of these errors—the mistaking of some other element for lead—the final lead sulphate precipitates from all the determinations were saved, combined, and the usual qualitative tests for lead applied. The reactions with potassium iodide and potassium bichromate, the behavior on charcoal before the blowpipe, and the electrolytic precipitation on the anode were all strongly and characteristically positive. Furthermore, the only elements at all

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[a] Hartley, W. N., and Ramage, H., The mineral constituents of dust and soot from various sources: Proc. Roy. Soc., vol. 68, 1901, pp. 97, 103-104.

[b] See Clarke, F. W., and Steiger, George, loc. cit.; also Clarke, F. W., Data of geochemistry, 1911, pp. 600-602, 643; and Lindgren, Waldemar, Mineral deposits, 1913, p. 414.

[c] See data and references cited by Pošepny, F., The genesis of ore deposits; Trans. Am. Inst. Min. Eng., vol. 23, 1893, pp. 223, 239-240; Clarke, F. W., Data geochem., 1911, pp. 173-197; and Lindgren, Waldemar, Mineral deposits, 1913, pp. 41-64, 89-93. See also Massol, M. G., Composition chimique des dépôts des eaux thermales d'Uriage (Isère): Bull. soc. chim., vol. 5, 1909, p. 404; Okamoto, Y., Minerals of Taiwan (Formosa): Beitr. Min. Japan, No. 4, 1912, pp. 157-188; and especially the extensive spectroscopic research of Bardet, in which he found traces of lead in all of 54 French mineral waters; Bardet, J., Étude spectrographique des eaux minerales françaises; Compt. rend., vol. 157, 1913, pp. 224-226.

[d] Dana, J. D., and Dana, E. S., System of mineralogy, 1892, pp. 165, 170; Hartley, W. N, and Ramage, H. loc. cit.; Campo y Cerdan, —, Ann. Soc. Espan. fis. quim., vol. 10, 1913, pp. 431-439.

likely to be present in large quantity in the soil and to contaminate the final precipitate are iron, aluminum, and the elements of the alkaline earth group. The combined lead precipitate was also tested for these. The sulphocyanate test showed the presence of a trace of iron, and the spectroscope disclosed a faint trace of barium. Calcium and strontium could not be found by the spectroscope and the delicate cobalt nitrate test failed to show any trace of aluminum or magnesium. Electrolysis of a solution made from the final precipitate left the cathode entirely blank, proving the absence of copper and other related metals. It may be considered certain that the material weighed as lead sulphate was actually that compound in at least a fair degree of purity.

To avoid possibility of the second error—accidental contamination with lead during the analytical process—every possible care was taken to procure reagents and utensils free from lead and to prevent its entry in dust from the air. Special reagents were used and all were carefully tested by blank tests. No dust-forming lead compounds were in use or handled in the laboratory during the work or for some time previous thereto. In addition, preliminary blank tests of a soil found to be free from lead were made, the method being used in all details. That these precautions actually were efficacious appears to be proven by the fact that some of the soils tested were found free from lead. Furthermore, it will be remembered that the method used included the double extraction of the soil, once with nitric acid and again with acetic acid and ammonium acetate. In most cases the filtrates from these two extractions were handled separately and the final lead sulphate precipitates from each were separately weighed. In 13 cases, one of these filtrates showed no lead, although lead was found in the other filtrate from the same sample. Six of these blanks were found on the nitric extraction and seven on the acetic. In all cases samples were handled in parallel groups of four or more, and in every case where no lead was found either in one filtrate or in both, lead was found in other samples handled at the same time, with the same reagents and utensils, and in the same way. It would appear that suspicion of accidental contamination with lead may be dismissed.

Concerning the third error—a possible numerical inaccuracy of the results—we are less certain. The analytical procedure is necessarily long and complicated. There is much chance both of the loss of lead and of the inclusion of small amounts of other substances with the final precipitate. Four preliminary tests, in which 10 milligrams of lead (in solution) was added to a lead-free soil and then extracted by our method, resulted in the recovery of 95 to 98 per cent of the added lead. This would indicate a fair accuracy for the method employed, but the tests are not sufficient in number nor sufficiently varied in character to afford entire assurance.

Further data in this connection are furnished by the results of duplicate determinations on certain of the samples. The data are given in Table 3.

TABLE 3.—*Results of duplicate analyses for lead.*

Sample No.	Lead (parts per million).		Sample No.	Lead (parts per million).	
	First analysis.	Second analysis.		First analysis.	Second analysis.
101	18.6	24.4	1301	25.3	0.6
301	23.4	3.6	1402	8.0	2.2
401	22.5	.4	1902	7.5	2.2
902	9.8	None.	2102	8.6	None.
1101	12.6	8.4	2202	13.4	.1

The agreement is far from satisfactory, especially since the second determinations are generally much lower than the first. It would seem possible that the first determinations were greatly in error because of contamination of the precipitate. Fortunately, some of the precipitates from these first determinations had been preserved unchanged. These were put again through the purification by alternate precipitation as sulphide and sulphate, with the results given in Table 4.

TABLE 4.—*Results of repeated purification of lead precipitates.*

Sample No.	Lead (parts per million).	
	Original weighing.	After repeated purification.
101	18.6	17.0
1101	12.6	15.0
2202	9.4	4.0
301 [a]	3.6	2.6

[a] Second analysis.

The agreement seems as close as could be expected with such small working quantities.

The discrepancies of Table 3 might be due to any one of three causes: (1) Too high results of the first determinations through contamination of the preciptates; (2) too low results of the second determination through loss of lead in the process of purification; (3) real differences in the lead content of the parts of the sample used for the two determinations. The third of these is a real possibility, especially if the lead found is a normal soil constituent. Lead normally present in the soil would probably occur as a comparatively important constituent of a few mineral grains. Its distribution in the soil mass would be anything but uniform. To take an extreme case, let us imagine it present as galena, a few grains of that mineral being

scattered through the soil. Repeated sampling of such a soil might show an extremely variable lead content, depending on whether the sample chanced to contain 10 fragments of galena, or 1 fragment, or none. It would not be possible so to mix such a soil as to obtain uniform aliquot samples. It is quite probable that something similar to this is the rule of occurrence of the minutest soil constituents, and discrepant analyses are quite to be expected.

However, we are unable to decide the real cause of the discrepancies of Table 3, and accordingly we can claim no great numerical accuracy for the data of Table 2. In our opinion it is more probable that lead has been lost in the analytical process than that the final precipitates were impure or contaminated with adventitious lead. Accordingly, we regard as the more reliable the higher rather than the lower of the discrepant results of Table 3, and, similarly, we regard the data of Table 2 as more likely to be too low than too high. Nevertheless, in making up Table 2 we have used the average of the determinations wherever more than one has been made on the same sample.

It will be apparent later that the unassurance of numerical accuracy in the results is not important practically. Allowing for all probable analytical errors, it can be considered certain that lead is present in the soils and that its amount is of the order of 10 parts per million, varying between zero and a maximum of perhaps 40 parts per million. All these values are so small as to have the same practical meaning.

There arises at once the question whether the lead may be regarded as a normal soil constituent or must be ascribed to fume or flue-dust contamination. It is not probable that smelter fume or flue dust would reach so far as the locations of the more remote soils in which lead was found, but it is not entirely impossible. In the effort to determine this matter, we have procured and analyzed several other soil samples from parts of the Coast Range far removed from the area in question. The results are given in Table 5. Samples A and B were collected by Mr. E. B. Watson, of the United States Bureau of Soils; samples 1, 2, and 4 by Mr. J. W. Nelson, of the University of California; and sample 5 by Mr. J. A. Armstrong, also of the University of California.

TABLE 5.—*Results of determinations of lead in Coast Range soils.*

Sample No.	Description.	Lead, parts per million.
A	Near Ukiah; virgin soil from steep hillside	1.8
B	Near Ukiah; virgin soil from rounded hills	5.8
1	Southwest slope of Mount Diablo, near Danville; probably virgin soil	None.
2	Santa Clara Valley, 4 miles east of San Jose; virgin soil from hillside	None.
4	Santa Clara Valley, 4 miles east of San Jose; 1½ miles southwest of Evergreen; virgin soil from valley floor	2.6
5	About 10 miles southeast of San Diego; black adobe from foothills	None.

It is nearly, if not quite, impossible that any of the soils represented in Table 5 had been subjected to industrial contamination. The fact that three of them showed no lead indicates that the quantities found in the other three were not due to analytical error or to contamination of the reagents, for the first five were treated exactly alike, run at the same time, and with the same lot of reagents. It appears, therefore, that minute amounts of lead may be normally present in Coast Range soils and it is quite possible that the lead found in the soils of the area under examination may be normally present in them and not in any way due to the smelter.

However, it will be noted from Table 2 that the soils of the more exposed group are slightly higher in lead than those of lesser exposure, and that the samples of the surface half inch are quite decidedly higher. In the light of the possible numerical inaccuracy of the results it would be unwise to ascribe much importance to this difference, but it seems sufficiently general among the samples to suggest a small amount of fume or flue dust contamination of the more exposed soils. It is apparent, however, that this contamination, if actual, has been very slight.

Our conclusions in the matter of soil pollution are as follows:

1. Arsenic is certainly a normal, though extremely minute, constituent of the soils of the region, and lead is probably so.

2. The past contamination of the soils by lead and arsenic from the smelter is possible but unproven and appears not to be susceptible of proof.

3. The quantities of lead and arsenic added, if any, have been small and of the same order as the quantities of these elements normally present in the soils.

In our opinion, the maximum amounts of lead and arsenic found are far too small to have any injurious effect on plants grown in the soils. Indeed, much larger amounts than those actually found would be without practical effect on the agriculture of the region. In this connection we refer to the opinion of Prof. C. B. Lipman, of the University of California, as given in his report on another page.

DATA REGARDING SOIL SAMPLES.

The stations from which samples were collected are numbered 1 to 24, inclusive, the locations being marked on the map comprising Plate XXXVIII. The numbers of the individual samples consist of the number of the station, followed by a zero, followed by a number designating the sample. Thus, 101 is sample 1 from station 1; 1202 is sample 2 from station 12, etc. In all cases sample 1 from a station is of the surface half-inch; sample 2 is the general soil to 10 or 12 inches, as noted elsewhere in this report. Thus, 101 and 1201 are surface samples from station 1 and station 12; 102 and 1202 are the general soil samples from the same stations. A description of the stations follows:

Station 1.

Brow of hill directly opposite Vallejo Junction and fully exposed to wind from smelter, about 1½ miles distant. From side of hill facing the bay and about 15 feet below crest of hill. Elevation approximately 190 feet. Used for pasture. Slope about 15° southwest.

Station 2.

Northeast slope of small hill directly northeast of station 1. Behind the first line of hills and not so directly exposed to fume. About 40 feet below top of hill on side away from smelter. Slope about 10° northeast. Elevation approximately 110 feet. Had been planted to grain in last season.

Station 3.

Southwest slope of high hill east of station 1. About 75 feet below top of hill and directly exposed to winds from the smelter. Slope about 18° southwest. Elevation about 225 feet. Used for pasture.

Station 4.

From bottom of a small slough leading westward from station 3 and into east side of small cove shown on map. Composed of material washed from the directly exposed slopes of the hills to the east, a drainage area of about one-third of a square mile. Slope about 2° down slough. Elevation about 25 feet. Not used agriculturally.

Station 5.

Top of low, rounded hill northeast of Carquinez cemetery. About 2 miles from the water front and separated therefrom by three rows of hills. Taken about 25 feet southwest of the county pesthouse (not occupied). Practically level. Elevation about 200 feet. Not used agriculturally.

Station 6.

Northeast slope of hill south of the place of witness No. 6, being on the first range of hills but on the side away from the smelter. About 50 feet below the top of the hill. Elevation about 250 feet. Slope about 20° northeast. Had been planted to grain in previous year.

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Station 7.

South slope of hill carrying old well derrick on road to Glen Cove. About 30 feet below top of hill, but not exposed to downward drainage from derrick site. Is on the side toward smelter and fully exposed to winds from that direction. but two rows of hills intervene, both higher than location of sample. Slope about 12° south. Elevation about 275 feet. Apparently was planted to grain in previous year.

Station 8.

From bottom of Glen Cove about 50 feet west of slough and just north of village. Not directly exposed to winds from the smelter, but has probably received drainage and alluvium from the hills to the northeast, which are directly exposed. Slope about 2° south. Elevation about 50 feet. Used for pasture.

Station 9.

From west slope of hill back of Dillon Point. About 150 feet below top of hill on side directly toward smelter and fully exposed. Slope about 10° west. Elevation about 150 feet. Used for pasture, but apparently once planted to grain.

Station 10.

From foot of hill west of alluvial flat of Southampton Bay. Sheltered from smelter by range of hills to west. Receives drainage from these hills, but from their unexposed slope only. Slope about 5° east. Elevation about 20 feet. From edge of grain field, beyond planting, but has been pastured by stock.

Station 11.

About 1 mile north of Midway road house on road going north. Taken on east side of road on top of small hillock, not exposed to drainage. About 3 miles from water front and shielded from smelter by three rows of hills. Slope very slight. Elevation about 150 feet. Used for pasture.

Station 12.

From west end of hill on water front at northwest end of city of Benicia. Fully exposed to winds from the smelter. About 30 feet below top of hill. Slope about 9° west. Elevation about 75 feet. Used for pasture. This is from near the location of one of the dust catchers of the commission.

Station 13.

Point on water front in city of Benicia at location of commission's air analysis station. Taken from side of road. Fully exposed to winds from smelter. Very slight slope. Elevation about 15 feet. Not used agriculturally.

Station 14.

In hills north of Benicia as marked on map. On southwest slope of small hill, facing toward smelter but behind shoulder of hill. Slope about 9° southwest. Elevation about 450 feet. Planted to grain.

Station 15.

On hills northeast of Benicia (Pl. XXXVIII). Exposed to winds from smelter, but about 1 mile from water front. From southwest slope of small hill on crest of divide. Slope about 10° southwest. Elevation about 200 feet. Planted to grain.

Station 16.

From small hill on southwest side of valley of Sulphur Springs Valley Creek (Pl. XXXVIII). On top of small hill. Over 2 miles from water front in direction of smelter and protected by hills back of Benicia. No slope. Elevation about 120 feet. Planted to grain.

Station 17.

About 3 miles south of Cordelia and about 12 miles from the smelter, with many high hills between. From foot of the northeast slope of hills. Slope about 10° northeast. Elevation about 50 feet. Used for pasture.

Station 18.

At mouth of American Canyon, about 2 miles west of Cordelia. From low hills at north side of canyon. Apparently fully protected from winds from smelter. Slope about 8° east. Elevation about 250 feet. Used for pasture.

Station 19.

In American Canyon, near summit (Pl. XXXVIII). From top of hill north of road. Apparently fully protected from winds from smelter. Very little slope. Elevation about 500 feet. Used for pasture.

Station 20.

From foothills west of Sulphur Springs Mountain (see Pl. XXXVIII). Possibly exposed to winds from smelter coming up the Napa Valley (7 miles), but important exposure by this path is not to be expected, as winds seldom blow in this direction. From road side. No slope. Elevation about 115 feet. Not used agriculturally.

Station 21.

At the southwestern foot of Sulphur Springs Mountain, about one-fourth mile north of Sulphur Springs. Taken on southwestern side of a small spur of the mountain, not exposed to drainage from main ridge. Protected from winds from smelter by over 5 miles of hilly country. Slope about 10° southwest. Elevation about 400 feet. Used for pasture.

Station 22.

West of southern end of Sulphur Springs Mountain, at head of south branch of Sulphur Springs Creek. Protected from winds from smelter by about 4 miles of hilly country. At foot of slope leading to hills to the south. Very little slope. Elevation about 480 feet. Planted to grain.

Station 23.

Hill on northeast side of alluvial flat at head of Southampton Bay. Fully exposed to bay but somewhat protected against winds from the smelter by the hills back of Dillon Point. From hillside facing toward smelter (southwest). Slope about 15° southwest. Elevation about 100 feet. Planted to grain.

Section 24.

From top of hill in grounds of United States Arsenal at Benicia. Partly sheltered from winds from the smelter by the city of Benicia and the hills west. Very little slope. Elevation about 150 feet. Not used agriculturally.

LETTER OF PROF. C. B. LIPMAN CONCERNING INJURIES BY METALS IN THE SOIL.

Below is presented a letter by Prof. C. B. Lipman regarding injuries to vegetation caused by salts of the heavy metals in the soil:

SELBY SMELTER COMMISSION,
San Francisco, Cal.

GENTLEMEN: In accordance with the request of Messrs. Shaw and Free, I beg to submit a statement with reference to the results obtained in experimental work carried out in my laboratories and greenhouses on the effects of salts of the heavy metals on barley, wheat, and vetch.

Of interest particularly in connection with the investigations of Messrs. Shaw and Free are the figures obtained on the effect of lead on the growth of barley. In growing two successive crops on soil treated with lead sulphate we have found that no damage to crops occurs unless the plants be put in immediately after the lead sulphate is incorporated into the soil. Amounts as high as 1,000 parts of lead sulphate per million have been used in a soil plentifully supplied with organic matter, without any damage whatever to the crop. Indeed, stimulation of the crop has been obtained with very considerable concentrations of lead sulphate (in excess of 1,200 parts per million.

Similar results were also obtained with copper sulphate, which shows that the amount of organic matter or of colloidal material in the soil regulates the point of stimulation or toxicity of the salt in question. Thus, for example, in a very sandy soil barley growth was much stimulated by the presence of 100 parts per million of copper sulphate, and amounts higher than that in that same soil showed a gradual toxicity as the concentration became greater.

In an adobe soil the point of highest stimulation was between 300 and 400 parts per million of copper sulphate, and in the same kind of soil to which much organic matter had been added the point of highest stimulation was 700 parts per million. In any case, however, stimulation by the use of copper sulphate at some point had been shown to obtain so far as barley is concerned.

It is particularly to be noted also that the copper compounds used are not such insoluble ones as are likely to occur in smelter wastes, but is the copper sulphate, which is an easily soluble salt.

Similar results, differing only in degree but not in kind, were obtained with zinc sulphate and iron sulphate, the latter having been used in very much larger quantities than even the zinc or the copper.

Considering that the largest amount of lead found in the soils by Messrs. Shaw and Free was equal to 25 parts per million, it would seem that lead as a factor in the destruction of plants, through its content in the soil, or through the latter's contamination from smelter wastes, would seem to be absolutely a negligible one. None of the amounts of lead which we used in our investigations was as low even as 25 parts per million on the basis of the weight of the soil, lead sulphate being used, and yet no toxic effect, but actually stimulating effects, from quantities far in excess of 25 parts per million parts of lead were obtained.

So far as arsenic is concerned, I can not make any statement based on our own experiments, because, although we have some work started along that line, it is not com-

pleted, and therefore we are unable to make definite statements. It would appear, however, from the experiments of Greaves at the Utah Experiment Station, that the bacterial flora at least, upon which crops depend for their available plant-food supply are very active, and may be stimulated by quantities of arsenic which are certainly not smaller than those which have been found by Messrs. Shaw and Free in the soils about the Selby smelter.

I wish to offer it, therefore, as my opinion, based on extensive experimental work with the so-called poisonous metals that are likely to be thrown down in the smelter wastes and thus introduced into the soil, that no damage can possibly come to any appreciable area of land around the smelter from the deposition of poisonous metals through the fumes of the smelter. No content of these materials in the soil as yet determined has shown itself to be great enough in our experiments to give anything but a stimulating effect to the growth of the plant, and although the smelter problem may be a serious one as regards sulphur dioxide gas and its effects on crops, it has no significance at all so far as the solid smelter wastes are concerned which are introduced into agricultural soil areas through the smelter fumes.

Very truly, yours,

(Signed.) CHAS. B. LIPMAN,

Professor of Soil Chemistry and Bacteriology, University of California.

REPORT ON WEEKLY AGRONOMIC OBSERVATIONS.

By Ralph W. Brown.

INTRODUCTION.

The object of my work was to collect data on the agricultural practices in the district lying between Benicia and Vallejo, and extending from the water front inland one to three miles. Data were collected also on soil, crops, and climatic conditions in this territory.

The data were obtained by weekly observations, the entire territory being gone over at each time. General observations were made on the region as a whole and specific observations made and data kept on a number of typical farms, as is noted later. In making these observations I went out into the fields and noted the various agricultural practices as they were being carried on. Data were taken each week on the farms being watched specifically, and also on other farms when anything new happened.

GENERAL REMARKS ON OBSERVATIONS.

These observations were begun December 6, 1913, and carried on until April 29, 1914. The dates upon which observations were made were: December 6, 16, and 17, 1913; January 8, 17, 24, and 31, 1914; February 7, 14, 21, and 28, 1914; March 7, 13, 20, and 27, 1914; April 3, 10, and 29, 1914.

The weather during the period of observation was mild. There was practically no frost and yet, with the exception of the middle two weeks of March, there was no really warm weather. The wind blew a great deal, usually starting about 10 o'clock in the morning and lasting until evening. During rainy periods, the wind was always from a southerly direction, usually a little east or west of direct south. During clear weather the wind was practically always from the west. Fogs were common in the mornings during December and most of January.

On December 1, 1913, a rain gage was installed at the location of sample station No. 12.[a] The rainfall for the season preceding that

[a] See p. 464.

date was obtained from the Benicia Water Co., which has a rain gage in the same locality. The rainfall was as follows:

Time.	Inches.
Month of November, 1913	5.22
Dec. 1, 1913, to Jan. 3, 1914	4.97
Reading Jan. 8, 1914	.42
Reading Jan. 17, 1914	2.92
Reading Jan. 24, 1914	2.95
Reading Jan. 31, 1914	.52
Reading Feb. 21, 1914	2.68
Reading Feb. 28, 1914	.38
Reading Apr. 3, 1914	.77
Reading Apr. 10, 1914	.83
Total for season	21.66

So far as climate and rainfall conditions are concerned the season has been ideal for volunteer crops and slack agricultural practices. Poor agricultural practice would not show up nearly so markedly this season as in those of lesser rainfall.

The soil of the district as a whole is not very deep, 1 to 3 feet being about the average. Ninety per cent of the pole holes dug for a private telephone line along the road leading directly north out of Benicia and extending about three miles showed a clay or sandstone subsoil. In practically no case were the holes deeper than 3 feet, as only 4 by 6 inch poles were used. As a whole, the tillable soil seems to contain a large percentage of clay, as it packs and runs together to quite an extent after rain. The soil gives the appearance of having been derived from thinly bedded sandstone and shales.

The acreage under general observation was approximately 8,000 acres. Practically all of this land that is cultivated is used for grain, namely, wheat, barley, and oats. A great part of the grain is cut for hay. A great deal of the land is either pastured or allowed to produce a volunteer crop.

Summer fallowing is practically never used in this region, and I was unable to find a seed drill on a single farm.

There are also a few orchards and vineyards. The vineyards are quite well taken care of, being pruned fairly well, and cultivated quite thoroughly. The orchards, on the other hand, receive little or no care. In no case did I find any spraying, and in only few places any pruning, and where the pruning was done, it usually showed a lack of knowledge in this line on the part of the workmen. Also, the orchards receive little cultivation, and it is the usual practice to sow grain in them if they are cultivated.

The general method of sowing grain in this region is to plow to a depth of 4 to 6 inches with a moldboard plow, broadcast the seed on this, and harrow it in.

SPECIFIC OBSERVATIONS.

The detailed data recorded as a result of observations are presented below:

Place of witnesses Nos. 1 and 1A, 80-acre field.

Eighty just east of house and adjacent to county road. No summer fallow. Plowed with 2-horse moldboard plow. Planted first week of December, 1913, one-third to wheat and two-thirds to barley. Sown with broadcast seeder. Harrowed in. Not very careful work.

January 8, 1914.—Grain up about 2 inches. From this time on the grain grew normally for the district, but became foul with weeds. Not a good crop for a season like this.

Place of witnesses Nos. 1 and 1A, 40-acre field.

On water front. No summer fallow. Ground not cultivated before sowing. Planted December 16 and 17, 1913. Seed broadcast with seeder on last year's stubble. After seeding, land gone over with four-horse cultivator, which did not turn soil, but merely scratched the upper couple of inches. Cultivator followed by harrow.

January 8, 1914.—Grain up about one-half inch.

January 31, 1914.—Owing to shallow cultivation, heavy rains, and clay content, the soil packed rather hard. From this time on grain made poor growth and thin stand.

March 27, 1914.—Rolled with heavy four-horse roller. Grain so high and soil so hard that roller had no effect whatever on soil, but bruised the grain considerably.

April 29, 1914.—Seems to be poor crop.

Place of witness No. 139.

Eighty acres. Plowed part of place December 16 and December 17, 1913, using two-horse moldboard plow.

February 14, 1914.—Plowed a couple more days. Finished plowing during first week of March. Planted entire place to barley with broadcast seeder.

March 5, 1914.—The parts plowed about the middle of December, and on which weeds were thick, were sown with the rest, making a poor job. The broadcast seeder was followed by a harrow, which left much of the seed uncovered in the weedy parts, but did better work on parts plowed just before sowing.

March 13, 1914.—Grain just coming through. Afterward this grain came on about normally for the district, but was weedy in parts; plowed in December.

Place of witness No. 12.

Acreage approximately 250. One hundred and fifty left for volunteer this year. Remainder sown to wheat, barley, and oats. Part under specific observation, about 15 acres adjacent to county road, sown to oats.

December 16, 1913.—No summer fallow. Being plowed with three horses on single-bottom plow. Apparently doing good work.

February 4, 1914.—No work done since middle of December because of wet weather. Part plowed during December sown to oats by broadcasting. Harrowed in.

February 28, 1914.—Grain just coming through; scarcely visible in wet sections.

March 20, 1914.—Poor stand on sown ground, which witness says is due to large flocks of blackbirds present at time of sowing.

April 29, 1914.—Cutting volunteer crop. A fine stand.

Place of witness No. 11.

Approximately 100 acres. Summer fallowed. Plowed early part of December, 1913, with gang plows, to a depth of about 5 inches. Planted to wheat with broadcast seeder, followed by harrow, about the middle of December.

January 8, 1914.—Grain up a couple of inches and doing well. From this time on grain made a fine growth, but the Hessian fly caused a good deal of injury during the hot spell in March.

April 29, 1914.—A good crop expected.

Place of witness No. 4.

Approximately 200 acres. No summer fallow. Planted as fast as plowed.

February 14, 1914.—Partly plowed and planted. Plowed with gang and two-horse plows. Planted to oats with broadcast seeder, followed by harrow. Broadcast seeder used, so seed was distributed rather irregularly, overlapping in some places, and in others missing by a few feet, some places sowing heavy and others light.

February 28, 1914.—Part first planted just coming up. Remainder being worked.

March 7, 1914.—Planting finished.

March 20, 1914.—Grain up all over field. Other than being somewhat irregular, the grain looks good for having been sown so late, owing to late rains.

Place of witness No. 8.

Approximately 100 acres. No summer fallow. Plowed with two-horse plows. Planted mostly to barley with broadcast seeder. Harrowed in.

December 16, 1913.—Upper end being plowed.

February 14, 1914.—Part plowed about middle of December being sown. Remainder being plowed down to lower end where there was too much moisture. Sown as soon as plowed.

February 28, 1914.—Grain up about one-half inch.

March 13, 1914.—Some of the lower land that was too wet when the other was worked is being planted. This part was disked, broadcast, and harrowed in. The lowest part of field could not be handled even at this late date. From this time on the grain came along all right, but the part disked in the wet soil is pretty foul with weeds.

April 29, 1914.—Stand of grain rather thin. Claimed to be due to large flocks of blackbirds, which were prevalent in district at seeding time.

Place of witness No. 6.

Approximately 5 acres. No summer fallow. Plowed with two-horse plow, about March 8, 1914. Soil rather dry, turned up cloddy. Planted to barley by hand broadcasting, giving uneven distribution of seed. Harrowed in, but soil so cloddy that the surface was left rough and seed cover shallow.

March 20, 1914.—Grain up about an inch. From this time on grain came along all right, because of the fine distribution of rain relative to the time this crop was sown.

Place of witness No. 48.

December 16, 1913.—Trees and vines dormant. Not pruned or cultivated. Vegetables for this time of the year look fine.

January 31, 1914.—Vineyard pruned.

February 7, 1914.—Hoeing vegetables.

February 14, 1914.—Planting some more vegetables.

February 28, 1914.—Trees in bloom. Vegetables look good.

March 20, 1914.—Planting more vegetables.

April 10, 1914.—Cultivating vineyard. Plowing with one-horse plow, grubbing around vines and harrowing.

April 29, 1914. Cutting hay. Fair crop.

The approximate area of this place is 25 acres, distributed as follows: 5 acres to vineyard; 5 acres to fruit trees, this part being sown to grain; 10 acres to grain and 5 acres to vegetables. Some of the grain is used green and this land put into vegetables. Trees not pruned or sprayed.

Place of witness No. 20.

About 2 miles north of Benicia. Area approximately 10 acres. No summer fallow. Pastured last year. Cultivated with spring-tooth harrow middle of December, 1913. This did not turn surface well but merely harrowed it to a depth of 2 or 3 inches. Hand broadcasted to oats and barley after above operation and seed harrowed in.

January 8, 1914.—Grain up an inch or so but very weedy. From this time on the grain did only fair, and is foul with weeds.

Place of witness No. 17.

Area approximately 10 acres. Located just across the road from place of witness No. 20. Plowed with two-horse plow middle of December, 1913. Hand broadcasted to barley and grain harrowed in.

January 8, 1914.—Grain up an inch or so and not nearly so weedy as place of witness No. 20. From this time on grain did well for the district.

Place of witness No. 16.

Area approximately 200 acres. Summer fallowed. Plowed with gang plows middle of December, 1913. Harrowed before planting to oats with broadcast seeder. Harrowed after seeding.

January 8, 1914.—Grain up an inch and a half. From this time on the grain did exceedingly well and is remarkably free from weeds for the district. One of the best stands in the district.

Place of witness No. 35.

Located just across road from place of witness No. 16. Area approximately 60 acres. No summer fallow. Plowed with a gang and two-horse plow middle of February, 1914. Sown about end of month to oats with broadcast seeder. Not sown heavily.

March 7, 1914.—Grain up about half an inch. Just after the middle of the month when the grain was about 2 inches high, the entire field was rolled with four-horse roller. From this time on grain made fair growth, but is a thin stand.

April 29, 1914.—Practically no crop.

Place of witness No. 27.

Area approximately 100 acres. No summer fallow. Plowed first week of January, 1914, with gang plows. Planted to oats with broadcast seeder first week in February, 1914. Harrowed in.

February 28, 1914.—Grain up 2 or 3 inches. Looks all right. From this time on grain made good growth, but became rather foul with weeds.

Place of witness No. 39.

Area approximately 200 acres. One-half of each side of road. Summer fallowed. Well plowed with gang plows the first week of December. Harrowed after plowing. Planted to wheat on north side of road and barley on south side, with broadcast seeder. Harrowed in.

December 16, 1913.—Grain up an inch or so and shows a good even stand. From this time on grain made a fine, even growth, remarkably free from weeds. This is one of the best grain crops in the district.

Place of witness No. 136.

Situated on the high road running northeast out of Vallejo and about 2 miles from the town. It is the last level piece of land just before entering the hills. Area

approximately 50 acres. Plowed with gang and 2-horse plows, about second week of December. Planted to oats with broadcast seeder. Harrowed in.

January 8, 1914.—Grain up about 2 inches.

January 24, 1914.—This place receives much seepage water, as it lies directly at the foot of the hills. Lowest parts of field yellowish in spots owing to excessive moisture.

January 31, 1914.—Low spots still show signs of excessive moisture. Remainder of place doing fair.

February 28, 1914.—All signs of excess moisture have disappeared and grain has taken on its natural color. From this time on grain was doing fairly well, but became so foul with weeds that at last observation crop looked to be poor.

INVESTIGATION OF LIVE-STOCK CONDITIONS AND LOSSES IN THE SELBY SMOKE ZONE.

By C. M. Haring, in cooperation with K. F. Meyer.

INTRODUCTION.

REASONS FOR THE INVESTIGATION.

In September, 1913, the Selby Smelter Commission petitioned the director of the California Agricultural Experiment Station, stating that they were unable to obtain qualified assistants to make a veterinary survey of the region between Vallejo and Benicia and report the pathological findings in animals that might die in that region. As this commission is an impartial body, appointed by a court of law, it seemed desirable as a public-service project to assist the commission. At the request of Mr. Ralph A. Gould, the secretary of the Selby Smelter Commission, I was authorized by Dr. Thomas Forsyth Hunt, director of the California Agricultural Experiment Station, to cooperate with the Selby Smelter Commission.

POINTS TO BE INVESTIGATED.

In consultation with Mr. Gould it was decided to make a survey of the live-stock conditions in the so-called "Selby smoke zone," situated in Solano County between Vallejo and Benicia. I was especially directed by Mr. Gould to determine the cause of any deaths that would occur in live stock and to report the autopsy findings in detail.

PLAN OF ORGANIZING THE WORK AND METHODS OF PROCEDURE.

At my suggestion, Mr. Gould asked Dr. K. F. Meyer, D. V. M., professor of bacteriology and parasitology, to act with me in this investigation. We employed William La Grange to take a census of the live stock and report on the methods of care and feeding in the area alleged to be exposed to smelter smoke.

Mr. La Grange was especially qualified for the work on account of his extensive experience with live stock under California conditions. He is a graduate of the University of California College of Agriculture.

He made a census of the live stock on 30 ranches and established a card system for identifying and reporting the condition of each animal. He arranged with the owners to phone the veterinary office, University of California, in case any of the animals developed sickness

or died. Mr. La Grange made weekly visits to the smoke zone during November. After that the work of observation was continued by Raymond S. Adams, Santa Cruz, Cal. His observations were supplemented by occasional visits by Dr. Meyer and myself.

The following veterinarians have also assisted us at various times:

Chester L. Roadhouse, D. V. M., associate professor of veterinary science in the University of California.

Fred M. Hayes, D. V. M., assistant professor of veterinary science at university farm, Davis, Cal.

Fred J. Wood, D. V. M., late veterinarian for the bureau of agriculture, Philippine Islands.

Dr. Roadhouse, Dr. Wood, and I also had an opportunity to tour the Selby smoke zone on July 15, 1914, with the following eminent veterinarians:

Veranus A. Moore, M. D., D. V. M., dean of the New York State Veterinary College, Cornell University, Ithaca, N. Y.

H. C. Gardner, D. V. S., Anaconda, Mont., veterinarian for the Anaconda smelter.

John Ernst, D. V. M., 125 East Fourth South Street, Salt Lake City, consulting veterinarian for the International Smelting Co.

LIVE-STOCK CONDITIONS IN THE SELBY SMOKE ZONE.

The area covered by our survey of the region alleged to be exposed to the smoke from the Selby smelter included 32 farms and small places lying between Vallejo and Benicia.

Our observations were made on the following dates:

1913.

Oct. 28. Haring and Meyer performed autopsy at place of witness No. 11.
31. La Grange visited ranches.

Nov. 4. Do.
7. Do.
8. Two of the horses of witness No. 23 were taken to Berkeley.
10. Haring and Bell performed autopsies at place of witness No. 11 and at place of witnesses Nos. 1 and 1A.
Specimens delivered to Meyer.
18. Meyer and Haring performed autopsy at place of witness No. 6.
20. La Grange visited ranches.
22. Do.

1914.

Jan. 21. Adams visited ranches.

Feb. 7. Do.
14. Do.
23. Do.
24. Roadhouse and Hayes operated on horses of witness No. 23 at university farm, Davis. One was killed and larynx delivered to Meyer.

Mar. 7. Adams visited ranches.

Apr. 11. Do.
13. Do.

1914.

Apr. 17. Hayes and Adams visited ranches.
18. Adams visited ranches. Horse of witness No. 23 was returned to Benicia.
21. Hayes and Wood immunized hogs at place of witness No. 6 and visited several other ranches.
30. Adams visited ranches.

May 1. Do.
15. Wood and Adams visited ranches.

June 15. Roadhouse and Hayes operated on horse of witness No. 6 in San Francisco.

July 8. Haring visited ranches.
15. Haring, Roadhouse, and Wood, accompanied by Moore, Gardner, and Ernst, visited ranches.
18. Wood visited ranches.

During the period of this investigation of the live-stock conditions on the 32 places above mentioned, there were inspected 308 horses, 315 cattle, approximately 900 sheep, and about 500 swine. These figures represent the number of animals inspected in bands or herds at pasture, or in corrals or pens, and also include 283 horses which were carefully observed, attention being given to each individual. The average conditions under which these animals are kept may be summarized as follows:

HORSES.

So far as the land, forage, and climate are concerned, the region between Vallejo and Benicia would seem to be suitable for the raising of horses. With the exception of the frequency of unsoundness in wind, which is described later, the condition of the horses will average about the same as in the regions of this State that are agriculturally similar. However, with a few exceptions, the horses are mediocre animals, and most of them would be classed as ordinary farm stock of no particular breed, the adult animals ranging in weight from 900 to 1,600 pounds. Some of the horses have the appearance of being "Standard bred," but of recent years there has been no market for good driving horses, and I doubt whether the best of these would bring over $150 a head if put at auction. There are a few teams of medium heavy horses that might bring $400 to $500 a span. Many of the animals are either aged or young and unbroken and would be hard to sell at $75 a head.

Most of the horses, except those that are being used for general farm work or teaming on the roads, are turned out on pasture. In the late winter, spring, and early summer of this year the feed was abundant. Last fall the field feed consisted of dry grass pasture and stubble fields, and in a few instances marsh or tule land. During the winter many horses were put up in barns during storms and fed grain hay without grain. In the late fall and early winter some of the animals that had not been caught up and fed were very rough looking and in poor condition of flesh owing to lack of feed.

Several of the farmers still fear that injurious fumes are coming from the Selby smelter and for that reason some bring the more valuable horses into the barns at night, believing that they are thus protected.

There is an unusually large percentage of horses in the smoke zone affected with roaring, a condition caused by the paralysis of certain nerves in the throat. This we (Haring and Meyer) attribute to injury by emanations from the Selby smelter. However, we have not been able to find any case that has developed between March and July, 1914. A detailed description of the cases of roaring in horses is given on subsequent pages.

WORK STOCK.

When worked the main source of sustenance for the horses is grain hay without grain. Some owners supplement this with rolled barley.

BROOD MARES.

Some of the mares are worked up to within a short time of foaling and then turned out on pasture or stubble fields and allowed to run out with foals until weaning time. At the place of witness No. 6 two very old animals with the suckling colts were fed a mixture of brown sugar, rolled barley, and alfalfa meal twice a day and ran out on pasture the rest of the time.

YOUNG COLTS.

Young colts are allowed to run out the year round in stubble fields and grass pasture, being fed a little hay in stormy weather and allowed to get shelter under sheds in some instances.

The photograph reproduced as Plate XXXIX, *A*, was taken July 7, 1914. The colts belonged to witness No. 12. The view of their environment is typical of the average pasture conditions in South Solano County and the smoke zone.

CATTLE.

With the exception of the large dairy of witnesses Nos. 1 and 1A, there are comparatively few cattle in proportion to the size of the farms. This, however, can not be attributed to fear of their being poisoned by smelter fumes, as all of the cattle owners, with one exception, reported that they believed no losses had ever occurred in cattle from "smelter poisoning." Witness No. 1 claimed that possibly two of his heifers had been "smeltered" and gave me an opportunity to autopsy them. The post mortem examination proved that they were severely infected with tuberculosis. No indications of chemical poisoning could be detected. During the late fall and winter the condition of the stock cattle in the smoke zone was bad, owing to lack of feed.

On account of the dry year, the pastures were poor. On the largest dairy ranch about all the dry cows and heifers had to eat during December and January was a poor grade of oat straw. The milking cows are fed hay and at a few places they also get concentrates during the fall and winter. They are fed and milked in barns. During the spring and early summer the pastures furnish enough to insure a milk flow. The stock cattle run out on grass pastures and stubble fields the year around. In the fall and winter of unusually dry years, like 1913, it is necessary to feed a little hay or straw. Some of the cattle are pastured on low tule lands and swamps near the bay.

SHEEP.

The sheep graze in stubble fields and grass pastures the entire year. In some places they are corraled at night as a protection against dogs and coyotes. During the winter, I was told, it was necessary to feed a little hay during stormy weather. No recent losses attributable to smelter smoke were reported by any of the sheep owners.

HOGS.

On most of the farms there are only a few hogs and these are maintained largely on the refuse from the houses. Witness No. 137 feeds a large number of hogs on the by-products of their creamery at Benicia, supplemented with a certain amount of mill feed. No losses in hogs which we (Haring and Meyer) attributed to smelter smoke were reported by any of the hog owners.

OCCURRENCE OF ROARING IN HORSES IN THE SELBY SMOKE ZONE.

Between October 28, 1913, and July 18, 1914, twelve cases of roaring (hemiplegia or diplegia laryngis) have been observed in the Selby smoke zone by veterinarians of the University of California. Following is a description of these cases:

CASE 1.

Owner: Witness No. 6.

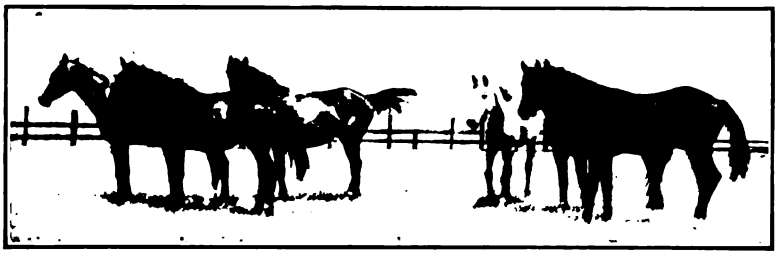
Location: Pastured on ranches rented by witness No. 11. Usually at ranch of witness No. 9.

Description: Aged bay mare with colt at side.

On October 28, 1913, Drs. Meyer and Haring and Mr. Wells went to one of the Selby Smelter & Land Co. ranches, rented by witness No. 11, to make a post mortem examination of a horse (see case N) that had died on October 24. The carcass was so decomposed that the post mortem gave little information worth recording.

While Drs. Meyer and Haring were working on the decomposed carcass the owner, who was working in an adjoining field, came,

A. YOUNG COLTS RUNNING LOOSE ON STUBBLE FIELDS AND GRASS PASTURE IN SMOKE ZONE.



B. HORSES IN SMOKE ZONE. ANIMAL FARTHEST TO LEFT IS "CASE 2."

C. MARE, DESIGNATED "CASE 4." PERSONS SHOWN, FROM RIGHT TO LEFT, ARE V. A. MOORE, H. C. GARDNER, JOHN ERNST, F. J. WOOD C. L. ROADHOUSE.

and later Dr. C. Massero, a veterinarian of San Francisco representing the Selby Smelting & Land Co., came over the hill. After cutting up and inspecting the decomposed carcass, we all went across the field to inspect the band of horses with which the dead animal had been pastured. Employees of witness No. 11 drove these past us and up a steep hill. The only one noticed to be abnormal in any way was the bay mare with a colt at her side which I recorded as case 1.

This animal, when exercised by running uphill, exhibited great difficulty in breathing and emitted a loud roaring sound in breathing, which, according to the owner, he had not observed in her before.

Following is a statement of the symptoms observed on this date:

SYMPTOMS OF CASE 1, OCTOBER 28, 1913.

The animal is rather thin, but the general appearance is healthy. After a short period of exercise the nostrils become widely distended and trumpet shaped. Respiration is labored, the inspiration sound being roughened and audible several yards distant. On galloping uphill inspiration sounds become very loud and strident, clearly audible at a distance of 100 paces; intercostal spaces sink in deeply on inspiration, making the ribs stand out with great prominence. She coughed several times with a wheezy tone. After two minutes' gallop severe dyspnœa developed, animal stumbled, made convulsive movements with neck and front limbs and would undoubtedly have fallen if exercise had been continued. On resting the symptoms rapidly diminished in intensity and to a person a few feet distant she showed no signs of unsoundness on standing at rest.

SYMPTOMS, NOVEMBER 7, 1913.

Animal was seen by Mr. La Grange. He reported that she was in thin condition, coughed, discharged from nostrils, showed labored breathing on slight exercise, and was about ready to die. Witness No. 11 told him that the mare belonged to witness No. 6 and that for about 18 months she had been on the ranches leased by witness No. 11. Previous to this it was reported that she had been in a runaway in San Francisco and after that had been shipped to this locality. Most of the time she had been at pasture on the place of witness No. 9. Previous to foaling she had been driven some. Until the latter part of October, 1913, no abnormal symptoms were observed by witness No. 11.

SYMPTOMS, NOVEMBER 10, 1913.

The mare died in the morning of this day and was opened by Drs. Haring and Bell. The parts of the carcass that were abnormal in appearance were taken to Berkeley and delivered to Dr. K. F. Meyer. Their description is given in his part of this report.

Field notes of Dr. Haring.

Following are the field notes taken by Dr. Haring on this date:

11 a. m. Witness No. 11 says mare has been on his ranches one and one-half years and that she is 6 years old. He sticks to this opinion in spite of evidence by the teeth that the mare is much older; objects to an autopsy until he can call his veterinarian, but finally consents since we have already opened the animal. The body of the mare is in the swamp northeast of the residence of witness No. 11, the mare having been moved here several days ago from the field where she was observed on October 28.

The skin is still warm, showing that the animal has just died. There are no external evidences of disease or violence. On dissecting the body and making a hasty examination, all organs and tissues appeared normal except the following:

The anterior lobes of both lungs were emphysematous.

The principal lobe of each lung contained in its inferior part a hepatized and gangrenous area about 6 inches in diameter. This was not sectioned, as we wished to keep it intact for Dr. Meyer.

The pleural cavity contained about 2 quarts of clear serum with some yellowish fibrinous exudate floating in it.

The heart surface was noticed to have numerous ecchymotic and petechial areas. There was some clear serum in the pericardial sac. The left ventricle of the heart and the anterior and posterior aortas, carotid, and axillary arteries contained a large antemortem blood clot.

The stomach was empty except for about 2 quarts of turbid water. A few small bots (gastrophilus equi larva) were attached to its walls.

(The lungs, heart, trachea, larynx, and part of the tongue were taken to Berkeley.)

Report of Dr. Meyer.

Report of Dr. Meyer is as follows:

On November 16, 1913, 5 p. m., Dr. Bell brought to the laboratory the respiratory tract, heart, and liver of a horse.

History of the specimen: Mare, owned by witness No. 6; pastured by witness No. 11 of Benicia; died November 10. Autopsied by Drs. Haring and Bell.

The anatomical findings were as follows:

The tongue is dark bluish; the larynx intensely reddened; the epiglottis presents marked ramifications. Both lateral pouches are filled with greenish-yellow exudate; the left side of the mucous membrane is more intensely reddened than the right. The left cricoarytænoideus muscles on comparison are flatter and lighter in color than the right; the larnyx is somewhat compressed from the left side; the left recurrent nerve is short (only 1 inch long), apparently somewhat darker in color, and flat. The right nerve, long, white, and soft. Thyroids are apparently normal; left somewhat smaller than the right.

The mucous membrane of trachea is covered by smeary, adherent, grayish-yellow, flocculent puslike material. There is marked injection and ramification of the lining. At the bifurcation of the trachea there is a brownish-yellow, frothy exudate. Also in the main bronchi similar brownish-black, fetid-smelling material is found. Mucosa is entirely covered by the exudate; when washed the membrane is slate colored.

A slight (compensatory) emphysema is found in left anterior lobe of the lungs. The pleura is infiltrated and gelatinous. Interstitiæ are distinctly gelatinous, and several foci of grayish discoloration are seen in the anterior part of the principal lobes. Some croupous pneumonic foci, the size of an apple, are seen in this region. These areas contain necrotic tissue of a greenish, smeary color and consistence. In another portion of the principal (left) lobe, a greenish discoloration indicates another cavity with necrotic contents. The connecting bronchi are filled with a yellowish-green exudate.

Throughout the left principal lobe the bronchi are surrounded by greenish discolored lung parenchyma. In the anterior lobe the interstitiæ are very large and bulging over the surface. These surround a yellow, gelatinous cavity, the size of a walnut, with brown-reddish, bad-smelling contents; the wall is fluffy and does not show any distinct wall. Several smaller cavities, surrounded by pneumonic foci of catarrhal character, are seen.

Throughout the right principal lobe the bronchi are filled with a purulent exudate.

Mediastinal lymph nodes are soft, enlarged, medullary on section. In some cortical parts, yellowish puslike areas are numerous.

Heart: Along the auricular groove is petechiæ and ecchymosis. On right ventricle are small hemorrhages and fibrous filaments. Blood fairly well coagulated, separated in chicken-fat clot and soft clot. Myocardium is fairly solid, but dry. Some areas are of yellowish discoloration. Valves are normal (blood culture from coronary artery).

Liver: Surface is covered with fibrous filaments. Several areas of soft yellowish color with central necrosis are in the middle lobe. Acini not very distinct; sections have a turbid, fatty color.

The blood culture revealed numerous cocci and bacilli which were not identified.

Anatomical diagnosis: Gangrenous pneumonia of both lobes of the lung, purulent bronchitis and tracheitis. Slight atrophy of the left side of the larynx; parenchymatous organs show signs of degeneration.

Cause of death: Septicemia due to gangrenous pneumonia, the latter being the result of aspiration of foreign bodies (food?) on account of disturbed function of the larynx and pharynx (probably neuroparalysis).

Microscopic examination of pieces of the recurrent nerves: Small pieces of the right and left recurrent nerves, which were taken as close as possible to the muscles, were fixed in formalin and sectioned, stained as usual, for connective tissue, myelin, etc. By comparison with normal nerves a slight increase of connective tissue with round cells around the bundles was noted; the number of bundles is reduced. The differences between the right and left nerves are not marked and in no way conclusive.

Epicrisis: Macroscopically, a distinct atrophy of the muscles of the larynx indicated a neuritis or neuro-degeneration of the innervating current nerve. The microscopic examination of a small portion of the nerve failed to reveal distinct advanced lesions. The affection is apparently of recent date and more along the line of disturbed function than marked anatomical alteration of the nerve structure.

CASE 2.

Owner: Witness No. 11.

Location: Place of witness No. 9, rented by witness No. 11.

Description: Iron-gray mare with two white hind feet; face white below forehead. Age, 4 years; weight 1,000 pounds.

Witness No. 11 reported that mare had been running at pasture for over a year. In the latter part of March, 1914, he had hitched her to a buggy and driven her about 12 miles. He observed that her respirations were abnormal.

SYMPTOMS, APRIL 21, 1914.

On this date she was examined by Dr. Hayes, Dr. Wood, and Mr. Adams. She was among a bunch of horses at pasture and it was with some difficulty that she was corralled. During this activity and after being caught she did not show abnormal respirations when the amount of exercise is considered, but when first starting to run had a short coughing spell. The owner stated that he had observed this coughing once before. The respiratory sounds over the trachea seemed to be somewhat coarser than the normal. According to Dr. Hayes there appeared to be a slight atrophy of the left superior laryngeal muscles.

SYMPTOMS, JULY 15, 1914.

She was observed by Dr. Haring and Mr. Nye at pasture with five other horses on the place of witness No. 9. On galloping across the pasture she coughed three times in a roughened wheezy way. Her nostrils dilated wider than any of the horses with her and remained dilated for several minutes after the canter, while the nostrils of the horses which had accompanied her showed no dilation.

REPORT OF DR. WOOD, JULY 18, 1914.

She was seen by Dr. Wood on this date. Following is his report:

After running in the pasture for a few minutes this mare showed dilation of the nostrils with rapid respiratory movements. This dilation of the nostrils was not noted in the other horses although they were subjected to the same amount of exercise. No cough noted.

The photograph reproduced as Plate XXXIX, *B*, was taken on the place of witness No. 9 July 8, 1914. The six horses belong to witness No. 11. The animal farthest to the left is case 2.

CASE 3.

Owner: Witness No. 6.

Location: Was known to be on the ranches of witness No. 11 until November, 1913, when she was taken to the ranch at Elliott Cove.

Description: Black mare, aged, weight about 1,000 pounds, wire cut on right front foot.

On November 10, 1913, seen at pasture at Elliott Cove ranch by Dr. Haring and Mr. La Grange. When at rest the mare appeared normal, but when driven up the pasture at a slow trot she developed a strident sound on inspiration that was typical of roaring. The nostrils became abnormally dilated and Dr. Haring was able to completely wind the animal in five minutes by running after her in the pasture. On palpation the superior muscles on both sides of the larynx were observed to be atrophied. The sounds continued after the animal had been cornered and brought to a standstill, but on reducing the size of the nasal openings by pressure of the fingers over the false nostrils the inspiratory sounds ceased, but began again on removing the pressure. Pressure on the larynx increased the abnormal respiratory sounds. After standing three minutes the sounds disappeared and the nostrils contracted to normal dilation. Pressure of the larynx between the thumb and fingers produced a fluttering sound during inspiration. Temperature, 100.8. Pulse and heart sounds normal. Lung tones loud but not abnormal.

OBSERVATIONS, NOVEMBER 18, 1913.

Mare reported to have been found dead.

OBSERVATIONS, NOVEMBER 20, 1913.

Autopsy performed by Drs. Meyer and Haring. The anterior lobe of the left lung was found to have several pockets containing food. Cause of death probably due to pneumonia, due to inhalation of food particles. For autopsy notes see the following report of Dr. K. F. Meyer.

Post-mortem report on the horse owned by witness No. 6.

November 20, 1913:

Medium nourished brown mare, about 16 years old; died on November 18, 1913. Cadaver placed close to the hole where the owner intended to bury it. The lower part of the limbs had been cut and the abdomen opened by the owner. The intestines were found in the burial place; most of the organs badly decomposed.

The lungs were examined as far as possible.

In the anterior part of the left principal lobe several cavities, varying from the size of a cherry to that of a nut, were found. Each cavity contained a liquid, dirty, brownish mass, which contained particles of feed (hay and grain). The surrounding of the cavities was solidified and mostly yellow reddish in color; distinctly granular. In the bronchi and trachea a considerable amount of greenish, granular, clumpy material. The mucous membrane dark black, thickened, and rough.

The larynx showed a distinct thickening of the mucous membrane, blackish discolored, and is covered with a clumpy, yellowish exudate; muscles soft and decomposed. Apparently the larynx is asymmetrical. The recurrent nerves are soft and discolored.

Anatomical diagnosis.—Gangrenous pneumonia, due to aspiration of food particles. Asymmetrical structure of the larnyx. Septicemia.

A histological examination of pieces of the recurrent nerves revealed only autolytic changes due to decomposition.

CASE 4.

Owner: Witness No. 23, Benicia.

Location: Ranch of witness No. 32, rented by witness No. 138.

Description: Bay mare; aged; weight about 975 pounds; white star and small white stripe in face, black stockings, white left front foot.

History: According to the owner and witness No. 138 this mare had been on the ranch of witness No. 32 for a number of years, and symptoms of unsoundness in wind had been present for several years and have gradually been growing worse.

SYMPTOMS, NOVEMBER 7, 1913.

Seen by Mr. La Grange. Although more suitable for a roadster, at present the animal is being worked in a plow team, it being possible to work her about four hours per day. Arrangements were made by Mr. La Grange to ship this mare to Berkeley, the owner to be paid $50 in case the animal is injured or killed.

SYMPTOMS, NOVEMBER 8, 1913.

Animal arrived in Berkeley. On examination by Drs. Haring and Meyer and Reed the following observations were noted:

General appearance healthy but rather thin. Mucous discharge occasionally from left nostril; submaxillary glands slightly enlarged. Breathing normal when at rest;

inspiration roughened when first trotted, later very labored inspiration and respiratory noise typical of roaring. After driving 4 minutes up hill respiration very labored and 44 per minute; active movements and abnormal dilation of nostrils, type of breathing costal abdominal, perspiration copious, labored locomotion. After 45 seconds' rest the strident respiratory sounds ceased. The conjunctival mucous membranes were slightly injected and became more so after driving. In the opinion of Dr. Meyer and Dr. Reed the left side of the larynx was slightly flattened, showing an atrophy of the last superior laryngeal muscles. Blood examination showed the red and white corpuscles to be normal in number and the various kinds of leucocytes to be in normal proportion. Hemoglobin normal.

SYMPTOMS, JANUARY 15, 1914.

No change noted since November 8. The mare was transferred to the University Farm, Davis.

SYMPTOMS, FEBRUARY 23, 1914.

No change had been noted since January 15, 1914. The appearance and temperature of the animal while at rest was normal. On exercise she showed the abnormal respiratory symptoms already described. After driving rapidly for one-third of a mile the animal was allowed to stand and in four minutes all abnormal respiratory symptoms had disappeared. Palpation of the larynx revealed atrophy of the superior laryngeal muscles on both sides and a tentative diagnosis of *diplegia laryngis* was agreed upon.

SYMPTOMS, FEBRUARY 24, 1914.

The mare was operated on in a standing position after the manner of Williams and Frost. On opening the larynx the muscles controlling the left arytenoid cartilage were seen to be completely paralyzed and those of the right to be partly paralyzed, verifying the diagnosis on the previous day. The operation was successfully completed although the cricoid cartilage became cracked.

SYMPTOMS, APRIL 18, 1914.

The animal appears to have completely recovered. No abnormal respiratory sounds or symptoms appear even during violent or prolonged exercise. She was returned to the owner at Benicia.

SYMPTOMS, JULY 8, 1914.

Witness No. 138 reports that for some time after her return from Davis the mare was perfectly sound. but lately she has been showing a return of her old symptoms. On examination by Dr. Haring he noticed that she held her head slightly extended as if her throat were sore. On palpation of the larynx he noted that it was hard and stiff, and when pressure of the fingers was made it felt like a mass of solid bone instead of the normally elastic cartilaginous box. In his opinion a chondroma was developing.

SYMPTOMS, JULY 15, 1914.

Mare was inspected by Drs. Haring, Roadhouse, and Wood, accompanied by Drs. Moore, Gardner, and Ernst. No change was noted since July 8.

The photograph reproduced as Plate XXXIX, *C*, was taken July 15, 1914, at the ranch of witness No. 32, Benicia, Cal. From right to left, V. A. Moore, Ithaca, N. Y.; H. C. Gardner, Anaconda, Mont.; John Ernst, Salt Lake City, Utah; (case 4, mare); F. J. Wood, Berkeley; C. L. Roadhouse, Berkeley.

CASE 5.

Owner: Witness No. 23, Benicia.

Location: Ranch of witness No 132, rented by witness No. 138.

Description: Black mare; aged; weight about 900 pounds; white stripe below right eye; white left hind foot. Poor teeth, thin condition.

History: Reported to be a daughter of case 4, having been for many years on the ranch of witness No. 32 and used with case 1 for a driving team and later when symptoms of unsoundness developed they were used mostly for light farm work. Symptoms of unsoundness in wind have been present for several years and have gradually been growing worse.

SYMPTOMS, NOVEMBER 7, 1913.

Same history as case 4.

SYMPTOMS, NOVEMBER 8, 1913.

Animal arrived in Berkeley in company with case 4. The description given for case 4 will apply in most particulars to this animal. She was somewhat thinner and weaker than No. 4, but the respiratory difficulty was not quite so pronounced.

DECEMBER 19, 1913.

Taken to the University farm, Davis, with case 4.

SYMPTOMS, FEBRUARY 23, 1914.

Similar symptoms as those described on this date for case 4. Palpation of the larynx revealed atrophy of the superior laryngeal muscles on the left side of the larynx and a tentative diagnosis of hemiplegia laryngis was agreed upon.

SYMPTOMS, FEBRUARY 24, 1914.

The animal was secured in a standing position and a local anæsthetic administered. The larynx was opened by making an incision through the skin and cryco-thyrodean ligament on the median line and parallel to the long dimension of the larynx. An inspection of the interior of the larynx through this opening showed that the left arytenoid cartilage remained motionless while the right one moved in a normal manner in accordance with the animal's respirations. This verified the tentative diagnosis of the day before of *hemiplegia laryngis*. It was decided to kill the animal. Following are the autopsy notes furnished by Dr. Roadhouse:

DATA SHOWN BY POST-MORTEM OF CASE 5.

Lungs: The middle lobe of the left lung was adhered to pleura over an area of about 1 by 3 inches. The periphery of the principal lobe was thin and unfunctionating, this area being about 2 by 5 inches.

The right lung adhered to the right wall over an area about 1½ inches in diameter.

Liver: The liver was normal in size. Its anterior border adhered to the diaphragm. Two concentric hepatic calculi, calcareous nodules (parasitic nodules) were found in the periphery of the liver.

Colon: The large colon was adhered to the liver. Measurements were taken of the heart and sent to Dr. K. F. Meyer. The larynx was removed and sent to him. All organs and tissues, except those above mentioned, were normal in appearance.

RESULTS OF EXAMINATION OF LARYNX OF CASE 5 BY DR. K. F. MEYER.

On February 26, 1914, examination was made of a specimen of the larynx of case 5, which had been fixed in formalin. Notes thereon are as follows:

The larynx has been opened in its upper part; also wounds in first cartilage ring of the trachea and in the left pouch are present. On reconstruction the larynx is asymmetrical, the left side of the vocal cord is closer to the median line than the right. The muscles are apparently slightly flattened on the left side, but no differences in color are noticed. The left recurrent, being rather long, is close to the insertion in the muscles; flat and thin compared with the right nerve. The difference exceeds the physiological limit, but no change in color is apparent.

Diagnosis.—Atrophy of the left recurrent nerve, and arytenoid muscles of the larynx.

The histological examination showed a general reduction of nerve bundles at the cost of connective tissue growth, which was also seen in the right recurrent.

According to the microscopical examination, the inflammatory process of the recurrent nerves, which is responsible for the muscular atrophy, was bilateral and would have finally led to a diplegia laryngis.

CASE 6.

Owner: Witness No. 4.

Location: Ranch of owner.

Description: Dark bay gelding; aged; gray white forehead and white right hind foot.

SYMPTOMS, NOVEMBER 4, 1913.

Observed by Haring and La Grange while in road; horse pulling up grade showing distressed breathing.

SYMPTOMS, MAY 15, 1914.

Examined by Wood and Adams. They detected atrophy of muscles on left side of larynx. No abnormal respiratory sounds noted while at rest, but roughened breathing could be produced by compressing the larynx. On account of objections by the owner, there was no opportunity to exercise the animal.

CASE 7.

Owner: Witness No. 4.

Location: Ranch of owner.

Description: Sorrel gelding, aged 10 years Three white feet and blaze on face.

SYMPTOMS, NOVEMBER 14, 1913.

Seen by Haring and La Grange. Owner claimed the animal was "smeltered," but objected to an examination.

SYMPTOMS, MAY 15, 1914.

Examined by Wood and Adams. Slight atrophy of left superior laryngeal muscles. No respiratory trouble was noted, but on account of the owner's objections the animal could not be exercised.

CASE 8.[a]

Owner: Witness No. 13.

Location: Ranch of owner.

[a] See Plate XL, *A* and *B*.

A. "CASE 8," NOSTRILS DURING EXPIRATION AFTER ANIMAL HAD TROTTED A FEW RODS.

B. "CASE 8," NOSTRILS DURING INSPIRATION.

Description: Black mare; age, 14 years; weight, about 1,400 pounds. Reported by owner to have been of unsound wind for a number of years. Large hernia on left side.

EXAMINATIONS MADE.

October 31, 1913, examined by La Grange and noted to be of unsound wind.

February 7, 1914, examined by Adams and condition noted.

March 7, 1914, examined and observed to be in same condition as at previous inspection.

May 1, 1914, mare had foaled recently and had developed a large rupture on left side.

May 15, 1914, examined by Wood and Adams; condition unchanged.

July 8, 1914, examined by Haring. Owner says unsoundness in wind has not changed for years. The symptoms were as follows:

Atrophy of both superior laryngeal muscles, but especially marked on the left side. Respirations and lung tones normal while animal is at rest. Compression of larynx produces fluttering sound during inspiration. On trotting slowly for 100 yards, typical symptoms of roaring developed, including dilation of and extremely active movements of the nostrils, strident sounds during inspiration, and labored costal abdominal breathing.

July 15, 1914, examined by Moore, Gardner, Ernst, and Roadhouse, and pronounced a typical roarer.

CASE 9.[a]

Owner: Witness No. 12.

Location: Ranch of owner.

Description: Bay gelding; age, 11 years; two white feet behind. Owner says animal has been unsound in wind for past six years.

EXAMINATIONS MADE.

October 31, 1913, examined by La Grange and unsoundness noted.

November 22, 1913, examined by La Grange. No change in condition.

February 7, 1914, examined by Adams. No change in condition.

March 3, 1914, examined by Adams. No change.

May 15, 1914, examined by Wood and Adams. No change.

July 8, 1914, examined by Haring. Symptoms since last fall have remained constantly as follows:

General appearance healthy, but rather thin. Breathing normal when at rest; inspiration roughened when first trotted; later very labored inspiration and strident respiratory noise typical of roaring which occurs only during inspiration. Nostrils are very active, dilating widely on inspiration and closing to normal on expiration. After prolonged severe exercise the nostrils remain widely dilated and trumpet-shaped during both expiration and inspiration and face becomes wrinkled from the efforts of respiration. During inspiration abdominal muscles contract vigorously, intercostal spaces sink in, and ribs become prominent. Palpation of larynx shows atrophy of superior laryngeal muscles on both sides of larynx.

July 15, 1914, case was seen by Drs. Haring, Roadhouse, and Wood in company with Drs. V. A. Moore, H. C. Gardner, and John Ernst, and pronounced to be a typical case of roaring of the diplegia laryngis type.

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[a] See Plate XLI, *A*.

CASE 10.*

Owner: Witness No. 12.

Location: Ranch of owner.

Description: Bay gelding; star and stripe on forehead; aged; lower lip pendulous.

EXAMINATIONS MADE.

October 31, 1913, examined by La Grange and unsoundness noted. Thin and in poor condition.

November 22, 1913, examined by La Grange. No change.

February 7, 1914, examined by Adams. No change in condition.

March 3, 1914, examined by Adams. No change in condition.

May 15, 1914, examined by Wood and Adams. No change.

July 8, 1914, examined by Haring. No change.

July 15, 1914, examined by Haring, Roadhouse, and Wood, accompanied by Moore, Gardner, and Ernst. The symptoms were similar to those described for case 9, except that in this animal they are more pronounced. Case 9 outwinded this mare, although No. 9 was drawing a buggy and No. 10 was led behind. This animal showed atrophy of superior laryngeal muscles on both sides.

CASE 11.

Owner: Witnesses Nos. 1 and 1A.

Location: Dairy of owner.

Description: Buckskin mare; black points; white feet; blazed face; weight, 1,300 pounds; age, 8 years.

EXAMINATIONS MADE.

November 10, 1913, examined by Haring. Owner reported case to be of long standing. Was a roarer when he bought her. When worked she showed typical symptoms of roaring. Vibrations can be felt over larynx. Atrophy of left superior laryngeal muscles.

February 7, 1914, examined by Adams. No change.

March 3, 1914, examined by Adams. No change.

April 11, 1914, examined by Dr. Hayes. No change.

CASE 12.

Owner: Witness No. 135.

Location: Benicia, at owner's place.

Description: Bay gelding; stripe on forehead and white hind pasterns. Age, 13 years.

EXAMINATIONS MADE.

November 22, 1913, examined by La Grange, and unsoundness noted.

March 7, 1914, examined by Adams. No change.

April 21, 1914, examined by Hayes and Wood. Marked respiratory sound on inspiration. Pressure on larynx increases sound of breathing. Horse is so thick about the larynx it is impossible to palpate the superior laryngeal muscles. Animal gives characteristic sounds of roaring.

PROBABLE CAUSE OF LARYNGEAL PARALYSIS IN TWELVE CASES MENTIONED.

The symptoms manifested in the above 12 cases are typical of the usual type of roaring due to hemiplegia or diplegia laryngis.

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* See Plate XLI, *B*.

A. "CASE 9," AFTER TROTTING A FEW RODS. NOTE DILATED NOSTRILS AND WRINKLED MUZZLE.

B. "CASE 10," AFTER TROTTING A FEW RODS. NOTE DILATED NOSTRILS.

The detection of muscular atrophy of the larynx in 10 of the cases clinched these diagnoses. Five cases showed atrophy of the superior laryngeal muscles on both sides. In cases 4 and 5 the effects of the paralysis in producing the partial closure of the glottis were seen through an incision into the larynx. This proved the correctness of the diagnosis beyond all controversy. Dr. James Law in his textbook of veterinary medicine has given a clear description of this appearance, which I quote as follows:

The modus operandi of this paralysis and wasting in the production of roaring is beautifully seen when the upper part of the windpipe is laid open so as to expose the interior of the larynx in laryngectomy. The triangular opening of the glottis is seen fairly dilated while the muscles are relaxed in the act of expiration. As soon, however, as inspiration commences the left arytenoid cartilage slides completely into the passage, its lower border projecting so much to the right that it forms a prominent crest extending beyond the median line and in some cases closely approaching the right wall of the larynx, the superior elastic and free border of the same cartilage meanwhile gets drawn inward by the suction power of the air so as to block up the passage still more. The closure of the glottis being thus seen to be largely controlled by the current of inspired air, it becomes evident that any increase in the force of the current will aggravate it and a decrease will lessen the extent of the closing and alleviate the distress of breathing. This fact explains why roaring should not be heard in quiet breathing and why it should increase in force and in pitch as the respiration becomes more and more hurried. It further accounts for the noise being heard only during the act of inspiration, the outer rush of the air in the expiratory act being of itself sufficient to carry this valvular cartilage out of the passage and secure a free and unimpeded current.

Roaring in horses due to laryngeal paralysis is described in nearly all books treating of diseases of the horse. I would refer particularly to the following:

Special report on diseases of the horse: Dept. of Agr., 1907, pp. 117, 210, and 223.

Veterinary pathology of Friedberger and Frohner, translated by M. H. Hayes, vol. 2, pp. 686–691.

Pathology and therapeutics of the disease of animals by Hutyra and Marek, authorized American edition of 1913, pp. 729–736.

Textbook of veterinary medicine, by James Law (second edition), vol. 1, pp. 146–161.

It is believed that there are a number of conditions that may bring on paralysis of the larynx in horses, and authorities differ as to what is the most frequent cause. Friedberger and Frohner attribute it chiefly to heredity. Hutyra and Marek say it is usually due to the after effects of infectious diseases. The fact that 50 per cent of the affected horses showed atrophy of the superior laryngeal muscles on both sides of the larynx eliminates the probability of inheritance, after effects of infectious diseases, pressure of enlarged bronchial glands on the left recurrent laryngeal nerve as it rounds the aortic arch, and other pathological conditions that usually affect only the left recurrent laryngeal nerve.

LITERATURE ON THE PULMONARY SYMPTOMS OF PLUMBISM IN HORSES.

Most writers mention chronic lead poisoning as one of the causes of roaring. The following most important references to observations concerning the relation of chronic lead poisoning to roaring in horses include the literature on this point so far as we have been able to find it:

Schmidt, Prussian Report, 1879, reports:

In the neighborhood of lead smelters, horses frequently become affected by lead, with symptoms of difficulties in breathing only. Disturbances of nutrition and other specific symptoms were entirely absent.

Mosslemann and Hebrant, Belgian Annals, 1899, report:

Eight horses on a farm which was situated one-half kilometer from lead works became affected with lead poisoning. A 3-months-old foal showed symptoms of foal evil. Two others, stiffness of the back and limbs. An old mare became affected with hemiplegia laryngis; was cured with treatment of potassium iodide. The same horse showed, later, during feeding, acute attacks of suffocation, with roaring cough, which finally ended fatally. Two other mares also showed acute roaring and dyspnea. The liver of the succumbed horses contained large amounts of lead.

Thomassen (Monatschriften für Psychologie and Neurologie, 1903, p. 423) has shown that the recurrent nerve showed pronounced degeneration in cases of lead poisoning of the horse. In several observations the entire nerve vagus was degenerated. He could experimentally reproduce the conditions by feeding horses with lead.

H. R. Thomassen (Monatshefte für praktische Tierheilkunde, vol. 13, p. 193, and vol. 14, p. 289), 1904, reports cases of hemiplegia laryngis due to lead poisoning.

H. R. Trumbower (Diseases of the horse, U. S. Department of Agriculture, 1907) says:

Lead poisoning may affect the lungs principally. In whatever system of the organs the lead is deposited mostly there we will have the symptoms of nervous debility most manifest. In it the lungs are affected and breathing becomes difficult and the animal gets out of breath quickly when he is compelled to run. Roaring also is frequently a symptom of lead poisoning.

Hutyra and Marek (Pathology of domesticated animals, vol. 2, English translation, 3d ed.), referring to hemiplegia laryngia, note lead poisoning from smelter as a frequent cause of this condition. Aspiration pneumonia and resulting gangrene are mentioned as resulting from laryngial paralysis due to chronic lead poisoning.

Finlay Dun (Veterinary medicines), quoting from Shenton, states that fits and partial paralysis came on at intervals, and when the animals got down they often struggled, for a long time ineffectually, to get up again. The breathing up to this period was tranquil, but now became so difficult and labored that the patients appeared in danger of suffocation. The pulse was in no case above 60 or 70, and

that he ascribed the difficulty of respiration to a paralyzed state of the respiratory apparatus. In the same paragraph he states that Mosselmann and Hebrant consider that the effects of lead poisoning in horses are especially manifested upon the vagus nerve, inducing roaring and dyspnea.

James Law (Veterinary medicines, vol. 1) states that paralysis of chronic lead poisoning will cause roaring.

Naunyn (Vergiftungen durch Schwer-metale und ihre Salze: Ziemssen's Pathologie und Therapie, vol. 15, p. 273) says that the paralysis of the respiratory muscles through lead poisoning is rare, but that it belongs to this great group is evident from the paralysis of these muscles in animals poisoned by lead. The horses in the lead mills frequently suffer complete paralysis of the vocal cords, which makes tracheotomy necessary.

Teleky (Zf. f. Neurologie, vol. 37, 1909) says that only those nerves become affected or degenerate most distinctly that supply the muscles exposed to the severest action. The muscles always atrophy. In most of the cases a certain distinct area of peripheral muscles is affected.

H. A. Vermeulen (Das Kehlkopfeifen beim Pferde, 1914, reviewed in Jour. Comp. Path. and Therapeutics, vol. 27, pt. 2, June, 1914, p. 173) puts forward what appear to be entirely original views regarding the etiology of roaring in the horse. He does not regard the disease as one localized in the larynx, but considers it to be one of widespread disease affecting the motor nerves and their centers. The condition is viewed as one of poisoning, the poison being some traces of mineral or vegetable origin, but in most cases a bacterial toxin or antitoxin, the last of these having its origin in disturbance of function of the thyroid gland.

COMMENTS ON THE PROPORTION AND DISTRIBUTION OF CASES.

It should be noted that the 12 cases of roaring above described are distributed among 8 owners. The total number of horses in the more exposed portions of the smoke zone is 140, making the proportion of roarers about 8.5 per cent of all the horses in this area. It is probable, however, that the true proportion is somewhat larger, as we have not positively diagnosed 11 suspected cases, 5 of which, on account of the objections of the owners or for other reasons, we were not able to study carefully enough to establish a positive diagnosis. These and other cases of pulmonary unsoundness are listed later in the section on live-stock survey.

If we assume that 8.5 per cent of the 140 horses in the area most exposed are roarers, it must be admitted that even such a percentage is larger than is usually encountered among horses. In order to substantiate this statement, we recommended to the Selby Smelter

Commission, in a report on June 22, 1914, that a live-stock survey be made of several near-by sections of identical or similar telluric and botanical conditions, with a view to determining the proportion of roarers. They have not seen fit to have this done (see letter from R. A. Gould, July 3, 1914), but, judging from our knowledge of live-stock conditions in several other sections of California which are agriculturally similar, we (Haring and Meyer) are justified in asserting that 8.5 per cent is an unusually large proportion of roarers. Under any circumstances this proportion would cause us to suspect some one cause for the trouble.

Of the numerous agencies that may be the cause of roaring in horses, the only one that we suspected in these cases was chronic lead poisoning. Reasons for this suspicion will be mentioned later in the discussion of the data collected in the general survey of all the live stock between Vallejo and Benicia.

The following table summarizes the distribution of horses in the smoke zone:

Distribution of horses and of cases in the smoke zone.

Witness No.	Total number of horses owned.	Cases of hemiplegia laryngis or pneumonia positively diagnosed.	Suspected cases of hemiplegia laryngis.	Cases claimed by owners, but no evidence found for such claim.
140 [a]	11		A and B	
37	47			
16	32			
4 [a]	9	Nos. 6 and 7	C	
17 [a]	5			D.
21	9			
141	20			
75 [a]	2			
13 [a]	10	No. 8		
12 [a]	21	Nos. 9 and 10	E and F	G.
5 [a]	5		H	
1 [a]	15	No. 11		K.
27	12			
18 [a]	6			
142 [a]	1		L	
143	3			
25 [a]	9		M	
144	15			
145	1			
29	3			
48 [a]	3			
24	12			
135 [a]	3	No. 12		
8 [a]	5			
28 [a]	7		N	
146	14			
23 [a]	3	Nos. 4 and 5		
11	[b] 18	Nos 1 and 2	O and P	Q.
6	[b] 7	No. 3		R, S, T, and U.
Total	308	12	11	8

[a] One of the horse owners who control the land most directly exposed to smoke. The total number of horses owned by these men is 140, about 8.5 per cent of which are roarers, while the percentage of proven roarers in the 308 horses in the entire area investigated is 3.9 per cent.

[b] The fact that witness No. 6 keeps buying, selling, and transferring old or unsound horses renders it impossible to draw any conclusions from the condition of his stock. The frequent transfer of horses between his land and the ranches rented by witness No. 11 renders it difficult to authenticate the history and methods of pasturing animals belonging to witness No. 11.

ANATOMICAL LESIONS FOUND IN CADAVERS OF HORSES THAT DIED IN SELBY SMOKE ZONE.

On account of the fact that we were rather unfortunate in atopsying (with one exception) only cadavers that had lain exposed to decomposition for more than 48 hours, the support the post mortem findings can give the epidemiological and clinical observations is meager.

In two cases (cases 1 and 3) out of three the diagnosis of a gangrenous pneumonia due to aspiration of food material was fully established. Such processes in the lung tissue lead always to septicemia, or blood poisoning; in rare cases the foreign body is incapsulated. The animal will then recover very slowly from the disease.

The causes for the aspiration of foreign particles into the lungs are numerous, in most cases mechanical obstructions or paralysis of the pharynx have been recorded. Swallowing the wrong way, owing to the paralysis of the pneumogastric nerve has also been seen, we are accustomed to speak of so-called "Vaguspneumonia's." The term would indicate that the pneumonia is the result of a diseased condition of the vagus or pneumogastric nerve. The mucous membrane of the larynx and upper part of the trachea is anaesthetic, the muscles of the larynx are paralyzed, and therefore are unable to expel any foreign body which has been aspirated.

In our cases (1 and 3) a diseased condition of the pneumogastric nerve, in form of an atrophy of the recurrent nerves, was noticed. Unfortunately, in the only case in which the material was fresh, the nerve piece sent with the specimen to the laboratory was very small, and instead of having the entire pneumogastric to examine, a small section of the recurrent nerve had to be used. The macroscopic changes noted were not conclusive, yet they support the microscopic findings—that a reduction in the number of nerve bundles had occurred.

As to the cause of this inflammation and degeneration of the nerve tissue of the pneumogastric nerve and its appendices, the work of Thomassen is of importance. He found, as a sequel to chronic lead poisoning "Vaguspneumonia's," following the paralysis of the pneumogastric nerve.

The anatomical findings on various laryngea (cases 1, 3, and 5) support the clinical diagnosis of hemiphlegia or diplegia laryngis. The organ was invariably more or less asymmetrical and showed atrophied muscles and recurrent nerves.

We have already explained the cause of these conditions and can only repeat that the occurrence of two cases of aspiration pneumonia in one locality in a short interval is exceedingly suspicious for a common cause.

Inasmuch as we believe that in all probability, lead has been the causative agent of the neuroparalysis and the subsequent roaring in the horses of the Selby smoke zone, the cases of aspiration pneumonia are not mere accidents or occurrences by coincidence, but are, in the light of Thomassen's work, the final and fatal results of chronic lead poisoning.

DETAILS OF THE CONDITION OF THE LIVE STOCK BETWEEN VALLEJO AND BENICIA, OCTOBER 28, 1913, TO JULY 18, 1914.

Following is a description of the condition of the live stock on each ranch in the area alleged to have been injured by the Selby smelter fumes. In this list the names of the live-stock owners are, as in previous pages, designated by numbers. The undoubted cases of hemiplegia laryngis are listed with the same case numbers under which they have already been described. The questionable cases of hemiplegia laryngis and the other diseases and unsoundness alleged by the owners to be due to the effect of the smelter smoke have been designated by letters of the alphabet.

Details of the condition of the live stock between Vallejo and Benicia, October 28, 1913, to July 18, 1914.

WITNESS No. 140.

Stock.—6 geldings, 5 mares, 5 cows.

Remarks.—Witness No. 140 has usually objected to an examination of his stock, and it has been impossible to procure complete first-hand information. On October 31, 1913, witness No. 140 told Mr. La Grange that one horse had the chronic form of smelter injury and was almost useless. On November 10, 1913, Dr. Haring called at ranch and examined two cases, A and B. Since then witness has refused any information.

Case A.—Bay gelding about 10 years old, white markings, stripe on face.

November 10, 1913, examined by Dr. Haring. No symptoms of abnormal breathing when run in corral, but owner states that animal shows distress when worked.

Case B.—Sorrel gelding, age 10 to 12 years, weight 1,400 pounds.

November 10, 1913, examined by Dr. Haring. No symptoms of abnormal breathing when at rest. Animal was in a plow team and had just been brought in from farm work. Owner says animal shows distress when worked.

WITNESS No. 37.

Stock.—47 horses.

Remarks.—Many of these horses are used at the tannery in Benicia at certain times. No trouble reported.

WITNESS No. 16.

Stock.—32 horses, 2 cows, 4 heifers.

Remarks.—No trouble. Owner claimed to have suffered loss in past, but not recently. He said he had to stop sheep business on account of losses supposed to be due to smelter.

WITNESS No. 4.

Stock.—6 geldings, 3 mares, 14 cows, 2 bulls.

Remarks.—Two geldings reported as "smeltered." These have been described. (See cases 6 and 7.) Objections by the owner interfered with thorough examination of stock. In addition to cases 6 and 7 the following doubtful case C was observed:

Case C.—Bay mare. Aged. White star on forehead.

Weight about 1,300 pounds. Examined May 15 by Mr. Adams and Dr. Wood.

Pronounced roaring sound on inspiration and grunting on expiration.

Trouble probably due to previous cases of pneumonia.

WITNESS No. 17.

Stock.—5 horses, 1 cow, 1 calf.

Case D.—Gray mare, 15 years old, said by owner to have been affected for 10 years. Found dead January 1, 1914. Was in poor condition before death. No autopsy performed.

No other animals reported "smeltered" at present.

WITNESS No. 21.

Stock.—9 horses, 5 cows.

Remarks.—No trouble exists at this time. Claims losses in the past.

WITNESS No. 141.

Stock.—50 cattle, 20 horses, 200 sheep.

Remarks.—No trouble reported.

WITNESS No. 66.

Stock.—4 ewes, 1 buck, 1 gelding, 1 mare, 2 cows, 2 calves.

Remarks.—Claims losses in the past in horses, cattle, and sheep. No trouble at present. Examined November 22, February 7, March 7, April 11, and May 1.

WITNESS No. 13.

Stock.—5 mares, 5 geldings, 2 cows.

Remarks.—No losses recently. The long standing case of roaring in a black mare has been described as case 8.

WITNESS No. 12.

Stock.—21 horses, 7 cows, 5 heifers.

Remarks.—No losses recently. Two horses on this place are claimed to show effects of past injury. These have been described. (See cases 9 and 10.) In addition, the following doubtful cases E, F, and G, are reported:

Case E.—Large, black gelding. Age, 8 years. White star on forehead; wire cut on right front fetlock.

Said to have been affected for the last eight years. This animal appeared normal while at rest. Condition good.

Case F.—Bay filly, 4 years old, white hind feet; used as saddle horse.

Atrophy of left laryngeal muscles noted. She had not been reported as "smeltered." The owner later stated that there seemed to be nothing the matter with the filly. Respirations appeared entirely normal at rest.

Case G.—Bay mare of witness No. 78, 8 years old. Claimed to be slightly affected.

These animals were reported on by Mr. La Grange on October 31, 1913, and November 22; April 21 by Dr. Hayes, Mr. Adams, and Dr. Wood; on May 15 by Mr. Adams and Dr. Wood; on July 8, 1914, by Dr. Haring; and on July 15, 1914, by Dr. Haring and others.

Witness No. 5.

Stock.—5 horses, 5 cows, 3 heifers.

Remarks.—The owner lives on a ranch owned by Selby Smelter & Lead Co. No trouble claimed of late years, but suspects that injurious fumes occasionally come across from the smelter. In the past the man claimed severe losses. The smelter company bought his ranch and permits him to remain there rent free.

Case H.—Roan horse on place four years, suspected by witness No. 5 of being slightly injured by fumes during the past year. Witness believes that injury from fumes occurs chiefly at night and if the horses are kept in at night no injury will occur.

Witness No. 1.

Stock.—250 cattle, 15 horses.

Remarks.—Two heifers, one mare, and one gelding were said to be "smeltered." The mare has already been described as case 11.

Case I.—Yearling heifer, very poor condition.

Was reported by the owner on October 31 as sick. This animal was killed on November 10 and an autopsy performed by Dr. Haring. Lesions of tuberculosis were shown in the lungs. There was no evidence of any other trouble.

Case J.—Black heifer reported October 31. In very poor condition. Was destroyed November 10 and an autopsy performed by Dr. Haring. Lesions of generalized tuberculosis shown.

Case K.—Dark brown horse. Weight about 1,500 pounds. Age, 9 years. This horse was believed by the foreman of the ranch to be "smeltered." The foreman stated that for a couple of weeks before our visit the horse had been off feed sometimes and had coughed and had some discharge from the nostrils. Respirations, pulse, and temperature were all regular, and there was no evidence of discharge from nostrils at this time, but auscultation of the trachea gave a respiratory sound indicative of bronchitis. No other symptoms were present and it is thought that the horse might have had bronchitis. (Dr. Hayes's report of Apr. 17.) May 15, was examined by Mr. Adams and Dr. Wood and was apparently a good recovery.

Witness No. 27.

Stock.—3 mares, 9 geldings, 2 cows.

Remarks.—No trouble reported.

Witness No. 18A.

Stock.—2 geldings, 2 fillies, 2 colts, 120 sheep.

Remarks.—Claims sheep used to grow thin and die from unknown cause. No trouble at present. Examined October 21, February 2, and May 1. No sheep on place May 1, 1914.

Witness No. 142.

Stock.—1 gelding.

Case L.—Solid gray horse. Weight about 1,000 pounds. Purchased four years ago. The owner stated that the horse had been affected for over a year, much worse in winter when the roads were heavy and the horse was used for buggy purposes. The horse was found on pasture in splendid physical condition. He was required to do very little work, as the roads were good and the owner stated that the symptoms were not very evident now. Pulse and respiration were normal. Palpation of the larynx showed a barely appreciable atrophy of the muscles on the left and superior parts of the larynx. July 15, seen by Dr. Haring and others. No symptoms.

Witness No. 143.

Stock.—3 horses, 4 cows.

Remarks.—No trouble reported.

WITNESS No. 144.

Stock.—90 cattle, 15 horses.
Remarks.—No trouble reported.

WITNESS No. 145.

Stock.—3 cows, 1 gelding.
Remarks.—No trouble reported.

WITNESS No. 29.

Stock.—3 mares, 3 sheep.
Remarks.—No trouble exists at this time.

WITNESS No. 43.

Stock.—3 horses, 1 cow.
Remarks.—No trouble reported.

WITNESS No. 24.

Stock.—12 horses, 35 cows.
Remarks.—No trouble reported.

WITNESS No. 135A.

Stock.—2 mares, 1 gelding.
Remarks.—The gelding is a roarer and has been described as case 12.

WITNESS No. 8.

Stock.—20 cows, 3 horses, 2 colts.
Remarks.—No trouble.

WITNESS No. 25.

Stock.—9 horses, 1 cow.
Case M.—One mare said to be affected by "smeltering." Bay mare, weight about 1,350 pounds, 9 years old. This animal was purchased from the Dos Reis place about 4 years ago, and was known to have shown symptoms of "smeltering" at the time of purchase.

WITNESS No. 28.

Stock.—1 horse, 6 mares, 5 cows.
Case N.—Aged bay gelding. Affected for several years. Apparently normal while standing in barn. Abnormal inspiratory sounds when exercised. Examination showed atrophy of left superior laryngeal muscles. Condition fair. Was reported on by Mr. La Grange on October 31, 1913; by Mr. Adams on February 14, and May 1; and on May 16 by Mr. Adams and Dr. Wood.

WITNESS No. 146.

Stock.—14 horses.
Remarks.—No trouble.

WITNESS No. 147.

Stock.—400 hogs.
Remarks.—No trouble reported. In November, 1913, a few hogs were sick, but recovered. Mr. La Grange thought the cause was dietary, possibly from drinking salt water.

WITNESS No. 23.

Stock.—3 horses.
Remarks.—Two affected with hemiplegia laryngia, and were taken to Berkeley on November 8, 1913. These have been described as cases 4 and 5.

Witness No. 11.

Stock.—18 horses, 8 cows, 700 sheep.

Remarks.—Two alleged cases of smelter injury belonging to witness No. 11 have already been described as cases 1 and 2.

Case O.—One horse died about October 24. Said to belong to witness No. 6, but pastured on ranch of witness No. 11. Cause of death unknown, as carcass was badly decomposed on October 28 when seen by Drs. Haring, Meyer, and Massero.

Case N.—Post mortem report on the horse of witness No. 6, pastured by witness No. 11, October 28, 1913:

Medium nourished horse; mare; cadaver bloated; from anus and mouth oozing of bloody, frothy fluid. In shoulder and hip region, large abrasions without hemorrhages. Subcutaneous tissue infiltrated with serous hemorrhagic fluid; gas bubbles.

Some fluid of reddish color in abdomen. Intestines tremendously distended by gas. Serosa diffusely stained, blackened, submucous gas bubbles. Liver, kidneys, and spleen in a state of advanced decomposition.

In thoracic cavity, reddish fluid with gas; pericard containing bloodstained fluid, imbibition of pericard with blood stain. Blood in heart, tar-like, containing gas bubbles. Lungs very rich in dark blood, but too advancedly decomposed to reveal structure. Larynx and pharynx displaced by fluid and gas masses which proceed along jugular groove.

Bacteriological examination of heart blood revealed putrifying bacteria: B. coli; streptococci.

Epicrisis: No definite diagnosis could be made on account of the advanced decomposition of the cadaver.

The animal probably died on October 24, 1913.

Case P (owner, witness No. 6).—Black mare on place of witness No. 11 in October and was later transferred to the ranch at Elliott Cove. Foaled sometime in March. Seen by Mr. Adams on February 7, 1914, March 7, 1914, and April 11, 17, and 30. Condition fair on ranch at Elliott Cove.

Case Q (owner, witness No. 11).—Light-roan mare. About 9 years old. Weight about 950 pounds. Purchased from a man working at the power company's plant (P. G. & E. Co.) and was said to be "smeltered" when purchased. On May 16 was examined by Mr. Adams and Dr. Wood, and seemed normal even after a short period of exercise.

Witness No. 6.

Stock.—5 horses, 2 colts, 2 cows, hogs.

Remarks.—Witness No. 6 keeps buying, selling, and transferring old or unsound horses, so it is impossible to draw any conclusions from the condition of his stock. In addition to case 3 already described the following were observed:

Case R.—Bay mare. Aged. With colt. Condition very bad, but no roaring when examined on November 10 by Dr. Haring. This mare died January 25, 1914, but no autopsy was performed.

Case S.—Bay mare. Was said by foreman to have shown symptoms of "smeltering," but this animal has never been examined as it was transferred to Vallejo.

Case T.—Brown filly. Two years old. Weight about 900 pounds. This animal was reported to have fallen down and bled from the nose and mouth after having been for some time in the field. No opportunity has been given for examination as the mare was transferred to Crockett.

Case U.—Light-bay mare; star on forehead. Age 15 years or over. There was little history obtainable concerning this animal. It was stated that she had been recently shipped from San Francisco. She had the appearance of having spent several years at hard work on city pavements. Her condition was fair. This animal was found on the hillside on the ranch at Elliott Cove. An abnormal respiratory sound

was distinctly evident during complete rest. Abnormal breathing was somewhat marked. Pulse and respirations were normal and the wings of the nostrils seemed to be dilated. Upon palpation of the larynx, a marked atrophy was present upon the left side of the larynx. This case appeared to be at this stage a typical "roarer," but of course could not be attributed to injury from smelter fumes as she was affected before leaving San Francisco.

On June 11, 1914, at the meeting of the California State Veterinary Medical Association, Dr. Roadhouse and Dr. Hayes performed Williams's roaring operation on this horse. On July 8 the animal was observed by Dr. Haring in a field at the ranch at Elliott Cove and noted to still roar badly.

INTERESTING FEATURES OF THE LIVE-STOCK SURVEY.

Most of the ranchers between Vallejo and Benicia state the belief that the injury from smelter fumes has occurred mainly in horses that were at pasture day and night. The opinion is prevalent that if the horses are kept in barns at night and not allowed in pastures until after sun-up little injury will occur. There is little complaint of injury during recent years. Those who allege that they have suffered loss claim that the symptoms develop in the late summer and fall.

Witnesses Nos. 5, 12, and 13 and others who have lived in Solano County a long time, explain that in the fall, when the pasture forage is dry and shrunken and there has been no rain for several months, the horses constantly at pasture got enough lead to produce injury.

We have already called attention to the fact that the proportion of horses affected with laryngeal paralysis is about 8.5 per cent of all the horses on the exposed ranches. There is reason to believe that in the past the proportion has been even higher than this, and as we have found that no injury has occurred during the past five months the proportion of roarers in time will probably decrease. Unless operated upon, horses affected with hemiplegia laryngis seldom recover. The University of California veterinarians have explained to the owners of the unsound animals that by an operation their animals could be cured. At least the operation is completely successful in about 70 per cent of the cases, and in the 30 per cent of failures the animals are usually no worse off than before the operation. We offered to perform these operations free of charge, but in only two instances (witnesses Nos. 6 and 23) were our offers accepted. However, in case no further injury to the animals occurs from smelter smoke, the proportion of roarers will in time probably decrease, owing to the dying off of the unsound animals, most of which are already advanced in age.

In considering the proportion of horses having laryngeal paralysis, it should be observed that most of the cases were found on farms known to be exposed to smoke from the Selby smelter, whereas on the farms not so directly exposed there were very few cases. An inspection

of the following list in connection with a study of the map will show the correctness of this statement:

Owners known to have cases: Witness No. 4, 2 cases; witness No. 13, 1 case; witness No. 12, 2 cases; witness No. 1, 1 case; witness No. 135A, 1 case; witness No. 23, 2 cases; witness No. 11, 1 case; witness No. 6, 2 cases.

Owners claiming cases, but whose claims could not be verified: Witnesses Nos. 5, 17, 25, 28, 140, and 142.

Owners reporting no cases: Witnesses Nos. 8, 16, 18, 21, 24, 27, 29, 37, 48, 75, 141, 143, 144, 145, and 146.

After noting the location and distribution of the cases of laryngeal paralysis, it is of interest to turn to the following figures, which we are permitted to use through the courtesy of Charles F. Shaw and E. E. Free, the agronomic experts of this commission:

The analysis of the soils conducted under the agronomic survey shows the presence of lead in practically all of the soils of the region and in such quantities as to make it difficult to state that the lead is wholly due to the smelter. It appears that lead in small quantities is a native constituent of the soils of that area. This can not positively be stated without a considerable amount of additional analytical work, which is not deemed by the commission to be necessary. The average amounts of lead found are as follows:

Average quantity of lead found in soil in Selby smoke zone.

Character of area.	Parts of lead per million parts of dry soil.	
	Surface soil.	General soil.
Exposed	15.2	4.8
Not exposed	2.9	4.1

In the matter of lead in the vegetation, we have determined this in a composite of six samples taken from exposed parts of the area, and find 21 parts per one million. This corresponds with about 0.9 gram per 100 pounds of fodder.

These figures are of interest in that they indicate a larger proportion of lead in the surface soil of the exposed areas than in the areas not exposed to smelter fumes. The proportion of lead in the soil is so small that it is of no significance as a source of direct poisoning.

The amount of lead in the vegetation is of more significance, but I know of no data available that would warrant the assertion that the consumption of 0.9 gram of lead per 100 pounds of hay, or about 0.25 gram of lead, per day by a horse would result in symptoms of chronic lead poisoning. In case it seems desirable, feeding experiments on horses could be carried out to determine this point.

SUMMARY OF LIVE-STOCK SURVEY.

The representatives of the pathology and veterinary divisions of the University of California, in visiting the ranches in Solano County that are in the area alleged to have been injured by smoke from the Selby smelter, so far as permitted by the owners, have inspected all the animals and have carefully examined every case of alleged unsoundness. Post-mortem examinations have been made on 4 horses, 2 heifers, and several hogs. No evidence or suspicion whatever of injury from smelter smoke could be detected in the cattle or hogs. In the horses there is evidence that considerable injury has occurred in the past, but we have not been able to discover any evidence of injury since March, 1914.

It would seem that an unusual number of horses in the smoke zone are affected with hemiplegia laryngis, or roaring, and there is reason to suspect that this affection in many cases has been caused by chronic lead poisoning. This suspicion is based on clinical symptoms, however, and not on chemical analyses. Thirty suspected cases of roaring, due to lead poisoning, have been observed, twelve of which have been carefully studied.

The assumption that most of the cases of laryngeal paralysis were caused by lead emanating from the Selby smelter, but that no injury is occurring at present, is justified on the following grounds:

1. The symptoms manifested are typical of the laryngeal paralysis described by various observers as having been caused by lead. Thomassen in particular has performed experiments and described results that are conclusive on this point. Our observation that 50 per cent of the roarers have diplegia instead of hemiplegia laryngis, and the observation of two cases of "Vagus pneumonia," eliminates the possibility of many causes other than lead poisoning.

2. There has been a large proportion of chronic roarers with the occasional development of an acute case in the area exposed to the fumes, in contrast to the absence of roarers in areas not exposed.

3. The usual occurrence of the roarers in the pastures exposed to smelter smoke, and their absence from ranches not so directly exposed, must be considered as evidence favoring the lead-poison theory.

4. The greater proportion of lead found by the chemists of the Selby Smelter Commission in the surface soils of the areas exposed to smelter smoke than in areas not exposed is worthy of consideration in this connection.

5. The almost unanimous assertion by the people living between Benicia and Vallejo that there has been little injury to stock for the past three years, coupled with the fact that we have not been able to find any evidence of injury since March, 1914, justifies us in the conclusion that until additional evidence can be found there is no

reason to believe that at present the smelter smoke is doing any injury to live stock in the Selby smoke zone.

CONCLUSIONS.

It appears probable that in the past considerable damage to horses has occurred in the smoke zone from lead emanating from the Selby smelter.

The effects of this previous injury are still evidenced by a number of long-standing cases of roaring in horses.

The clinical symptoms of roaring in these horses are due to partial paralysis of those muscles of the larynx supplied by the recurrent laryngeal nerves. This paralysis is probably due to the ingestion of lead. In some cases aspiration pneumonia, on account of the paralysis of the pneumogastric nerve, had developed.

The value of the animals affected is reduced 50 to 90 per cent, according to the severity of the paralysis.

In two cases fatal results have been brought on through the inhalation of food particles, which results in gangrenous pneumonia (so-called "Vagus pneumonia").

To date (July 19, 1914), we have not been able to find any evidence of injury since March, 1914.

There is no evidence or suspicion that the smelter smoke has ever injured cattle or hogs.

It is claimed by certain owners that sheep have been injured, but we have been unable to procure any clinical evidence to substantiate such assertions.

Until additional evidence can be found, there is no reason to believe that the Selby smelter smoke is doing any damage to live stock at present (since March, 1914).

BIBLIOGRAPHY ON THE EFFECT OF SULPHUR DIOXIDE ON VEGETATION AND ANIMAL LIFE.

Prepared by the CHEMISTS' CLUB LIBRARY.

ANONYMOUS. Injuries to vegetation by industrial gases. Rauch und Staub, vol. 3, 1913, pp. 109–112. Article states that in all cases of injuries caused by SO_2, the determination of the sulphuric acid content of the injured vegetation, is conclusive evidence. A number of analyses from various localities are given to substantiate this statement. In every case the SO_3 content is proportional to the extent of the injury. Detailed data presented are as follows:

SO_3 content in healthy plants, 0.540 per cent; injured by SO_2: injured leaves, 1.005 per cent; new healthy leaves, 0.640 per cent.

Ash and sulphuric acid content of dry substance of injured needles and leaves.

Tree.	Content of brown parts of—		Content of green parts of—	
	H_2SO_4.	Ash.	H_2SO_4.	Ash.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Firs	0.929	4.11	1.104	5.73
	.763	5.00	.806	5.08
Oak	.941	4.02	1.023	4.96
Beech	1.028	4.66	1.058	5.40
	.957	5.36	1.063	6.44
Average	.924	4.63	1.011	5.52

Sulphuric acid content of injured leaves on injured tree, 0.769 per cent; of healthy new leaves, 0.516 per cent; of healthy tree, 0.429 per cent.

Sulphuric acid in soils around trees.

Source of soil.	Sulphuric acid content.	
	Oak tree.	Beech tree.
	Per cent.	*Per cent.*
At root	0.162	0.082
Some distance from root	.043	.024
An injured part of forest	.026	.022

Case I.—Source of Smoke, Coke Ovens.

Clover—Injured plants.

Sample No.	Appearance.	SO_2 content, per cent.
I.	Entire leaf surface gray to grayish brown, few spots, and edges	1.542
II.	As above, but less marked	1.198

Clover—Healthy plants.

III.	Normal	0.824
IV.	Normal	.807

Elders—Injured plants.

I.	Leaves, dried up, black	2.330
II.	Normal	1.107

Case II.—Source of Smoke, Rolling Mill.

Pines—Injured needles.

I.	Needles turned completely red, only very few young needles still present	0.449
II.	Practically only young needles, turned entirely red. Some needles with very red tips	.317
III.	Mostly green needles with reddish-brown tips. In some cases entirely red young sprouts	.415

Pines—Healthy needles.

IV.	Apparently healthy, only occasional reddish-brown tips	0.293
V.	Normal	.273
VI.	Normal	.220
VII.	Normal, well-developed	.267

Case III.—Source of Smoke, Coke Ovens.

Firs—Injured needles.

I.	In part entirely brown, in part with brown tips	0.876
II.	Bright green with more or less pronounced brown tips, extending halfway, also some entirely brown	.672
III.	Bright green, only a few needles with brown tips	.413

Firs—Healthy needles.

IV.	Bright green, well-developed, normal	0.286

Case IV.—Source of Smoke, Coke Ovens.

Clover—Injured plants.

I.	Leaves with numerous large and small yellowish-brown to brown spots and edges	1.215
II.	As in I; spots not so numerous	1.236
III.	Only occasional, slightly brownish edges	.726
IV.	Leaves with pronounced yellowish-brown spots and edges	.933
V.	As in IV	1.033
VI.	As in IV, but less marked	.885

Clover—Healthy plants.

VII.	Normal	0.568
VIII.	Healthy	.522

CASE V.—SOURCE OF SMOKE, COKE OVENS.

Potatoes—Injured plants.

Sample No.	Appearance.	SO_2 content, per cent.
I.	Leaves in part entirely dry, in part with pronounced brown spots and edges	2.349
II.	As in I, but less marked	1.361
III.	Leaves in part dry, in part pronounced brown edges and spots	1.603
IV.	Slightly injured	1.200
	Potatoes—Healthy plants.	
V.	Normal, well-developed	0.647
	Beans—Injured plants.	
VI.	Leaves small with numerous yellowish-brown spots	1.250
	Beans—Healthy plants.	
VII.	Leaves healthy green, not very well-developed	0.583
	Clover—Injured plants.	
VIII.	Leaves with brown spots	1.201
	Clover—Healthy plants.	
IX.	Healthy, normal	0.601
	Wheat—Injured plants.	
X.	Leaves with white edges, to some extent yellowish brown facing the coke ovens	2.244
XI.	As in X, but at a greater distance from the coke ovens	
	Wheat—Healthy plants.	
XII.	Normal, slight white edges	1.747
	Oats—Injured plants.	
XIII.	Major portion of leaves pronounced yellowish brown	2.012
XIV.	Leaves partly yellowish brown, otherwise well-developed	1.110
	Oats—Healthy plants.	
XV.	Normal, green	2.552

CASE VI.—SOURCE OF SMOKE, COKE OVENS.

Clover—Injured plants.

I.	Leaves mostly entirely pronounced brown or with brown edges and spots	1.088
II[a].	As in I, but less marked	.964
III[b].	Normal	.734
IV.	Leaves with pronounced brown spots and edges	1.286
V.	As in IV, but less marked	1.191
VI.	As in IV, but less marked	1.133
	Clover—Healthy plants.	
VII.	Normal	0.830

[a] Taken at a distance of 100 meters from sample I.

[b] Taken at a further distance of 800 meters from sample I and protected from the smoke gases by a forest.

Potatoes—Injured plants.

Sample No.	Appearance.	SO_2 content, per cent.
VIII.	Greatly injured; numerous brown spots and edges	2.357
IX.	As in VIII, but apparently less marked	1.931

Potatoes—Healthy plants.

X.	Healthy, normal	1.039

CASE VII.—SOURCE OF SMOKE, COKE OVENS, ROLLING MILL.

Clover.

I.	Numerous yellowish-brown spots and edges	1.577
II.	As in I	1.546
III.	As in I	1.487
IV.	Injured only to slight extent	.973
V.	Normal, healthy	.478

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ASCHER, ——, and OTHERS. First report of the Königsberg commission for the prevention of smoke. Reprinted in Schriften der Physikalisch-ökonomischen Gesellschaft Königsberg, vol. 48, No. 2, 1908. Abstracted in Gesundheits-Ingenieur, vol. 31, pp. 429–430. Describes a method for determining the SO_2 content of air.

BRIZI, ——. Injuries to vegetation caused by smoke from industrial plants. Stazioni sperimentale agrarie italiane, vol. 36, 1903, pp. 279–384. Abstracted in Zeitschr. für Pflanzenkrankheiten, vol. 14, 1904, pp. 160–163. Treats extensively of the injuries to vegetation caused by smelter fumes; describes the various signs of injury; includes results of laboratory tests to show that field damage can be reproduced in the laboratory by burning sulphur to sulphur dioxide.

COHEN, ——, and RUSTON, ——. Smoke: A study of town air. London, 1912, 88 pp. Contains a chapter on gaseous impurities, including the sulphur acids.

CROWTHER, ——, and RUSTON, ——. The nature, distribution, and effects upon vegetation of atmospheric impurities in and near an industrial town. Jour. Agricultural Sci., vol. 4, No. 1, 1911, pp. 25–55. Abstracted in Botanisch. Zentralbl., vol. 117, 1911, p. 631. The investigations were made in and near Leeds, England, and covered a period of three years. The extent of the injuries was determined by a study of the rain water collected during that period and its action on vegetation. Free acid included both sulphur dioxide and sulphuric acid, but was calculated as the latter. Both potted plants and grasses were subjected to the action of rain water and dilute acid solutions. The presence of free acid is detrimental to vegetation, first, by direct action upon leaves, and, second, by inhibition of the activity of nitrifying and nitrogen absorbing bacteria

of the soil. The continued application of acid rain water tends to decrease the protein content of grasses, etc., and to increase the amount of crude fiber, thus diminishing the nutritive value.

DI STEFANO, ——. Method of ascertaining damage done to cultivated plants by sulphur dioxide. Stazioni sperimentali agrarie italiane, vol. 46, pp. 580–582; Chem. Abs., vol. 8, No. 15, 1914, p. 2739. Author states that in the case of annuals, the whole foliage may be used; with trees only the leaves affected should be. The sample should be protected from the heat and from drying. Five grams of the ground material is treated with distilled H_2O, stirred with a glass rod, covered and let stand 48 hours in a cool place out of the sun's rays, being stirred occasionally. Ten c. c. is decanted into a test tube, 1 c. c. of 2 per cent HI is added, and the mixture is stirred. Then 1 c. c. of $CHCl_3$ is added and thoroughly mixed. If a violet color appears SO_2 is present. If a negative result is obtained, the test should be repeated after the H_2O extract has been allowed to stand another 24 hours.

EATON, ——. On the effect of arsenical and sulphur fumes on vegetation Agricultural Bulletin of the Straits Settlements and Federated Malay States, 1910, vol. 9, pp. 46–51. Abstracted in Exp. Sta. Rec., vol. 22, p. 646. States that in view of the supposed deleterious effect of the fumes from the Chinese furnaces roasting low-grade tin ores, a small furnace was erected in the grounds of the Institute for Medical Research, and actual experiments were conducted with a number of potted rubber plants.

EBAUGH, W. C. Gases versus solids. An investigation of the injurious ingredients of smelter smoke. Jour. Am. Chem. Soc., vol. 29, 1907, pp. 951–970; Chem. Abs., vol. 1, p. 2868. States that the effect of sulphur dioxide was studied by the action of the gas upon sugar beets and alfalfa growing in Utah. The apparatus consisted of a sectional cabinet, 4 by 4 by 4 feet, through the top of which was suspended a fan for mixing the gases, several thermometers, and an inlet tube for SO_2. The tube consisted of a two-way stopcock, one branch of which led to a bottle containing a known amount of iodine. The experimental plants were isolated and surrounded by the cabinet. Definite concentrations of SO_2 were used, and the amount introduced was determined by absorption in iodine. The dilute gas remained in contact with the plants for one hour and was then removed by opening the door and permitting access of fresh air. The process was repeated at definite intervals. When diluted to the amounts that can be present in the air from a smelter, sulphur dioxide must be applied repeatedly to plants to cause material injury. Contrary to Haselhoff and Lindau, damage is rare during clear dry weather, but usually occurs during damp weather. The effect of aqueous solutions of sulphur dioxide and sulphuric acid was also studied, together with the action of the solid particles of smoke on vegetation, and the conclusion is drawn that in the past too little emphasis has been placed on the latter factor.

EICKE, ——. Damage from smoke in the Rhenish-Westphalian industrial district. Rauch und Staub, vol. 3, 1913, pp. 162–167; Chem. Abs., vol. 7, p. 2276. Contains a review of papers of others, but presents no original work.

FARNET, ——. Effects of locomotive fumes on leaves of plants. Rev. Patologia vegetali, vol. 2, 1907, pp. 113–128.

FEIST, ——. Proof of an injury to pines by roasting gases. (SO_2). Archiv. der Pharmazie, vol. 249, 1911, pp. 7–9. Abstracted in Botanisch. Zentralbl., vol. 116, p. 553. The fact of injury was established by the comparative analyses of injured and uninjured pine needles. In the former, both the sulphuric acid and the ash contents were increased, as was true of the soils in which the injured needles were grown.

Results of analyses.

Substance analyzed	Ash.	H_2SO_4.
	Per cent.	*Per cent.*
Healthy pine needles	4.59	1.09
Injured pine needles	6.04	1.69
Soil from district producing healthy needles	.....	.14
Soil from district producing injured needles	.....	.17

FRAZER, PERSIFOR. Causes of injury to vegetation in an urban villa near a large industrial establishment. Trans. Am. Inst. Min. Eng., vol. 38, 1907, pp. 498–519. Includes a bibliography of 46 references. States that injury to vegetation is mainly due to the sulphur oxides in the smoke from industrial plants. In order to verify this statement a series of tests was undertaken, in which the sulphur oxide content of the air around a large plant was determined under all sorts of conditions, and it was established that as a result of the combustion of fuel there was sufficient SO_2 and SO_3 in the atmosphere to have caused all the injuries manifested. Special apparatus was used in the analyses.

GEMUEND, ——. Atmospheric impurities in large cities. Deutsche Vierteljahresschrift f. oeffentliche Gesundheitspflege, 1908, pp. 401–429. General discussion emphasizing effects of dust and soot. The latter contains absorbed sulphur dioxide and sulphuric acid, which have a caustic action on the respiratory organs when inhaled. No experimental data are given.

GERLACH, ——. Beitraege zur Ermittlung des Holzmassenverlustes in folge von Rauchschaeden. (Notes on determining the loss of wood due to injuries by smoke.) Berlin, 1910, 81 pp.

———. Die Ermittlung des Saueregehaltes der Luft in der Umgebung von Rauchquellen und der Nachweis seines Ursprungs. (The determination of the acid content of the atmosphere in the vicinity of sources of smoke and the identification of its origin.) Berlin, 1909, 29 pp. The table of contents is as follows: Preface; 1. Basic principles and methods of my qualitative and quantitative analyses of smoke; 2. Description of, and directions for, improved smoke-analysis apparatus, models 1908 and 1909, German Gebrauchs Muster, Nos. 347784 and 373496; 3. Results obtained up to the present with the analyzer; 4. Conclusion.

———. Observations on, and experience with, characteristic means of showing, or signs of, smoke injuries. Oesterreich. Forst und Jagd Zeit., vol. 25, 1907, pp. 145–148. Abstracted in Botanisch. Zentralbl., vol. 105, 1907, pp. 360–361; Jahresber. der Vereinigung der Vertreter der angewandte Botanik, vol. 6, pp. 75–76. Describes various characteristic phenomena that give evidence of smoke damage, such as the presence of certain insects, the lowering of the power of evaporating water, etc.

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GRAFE, VIKTOR. Injuries to vegetation by waste gases and effluents. Monatshefte f. Landwirtschaft, vol. 2, No. 1, 1909, p. 19.

GRIMALDI, ——. Injuries to vegetation caused by fumes from a copper smelter. Stazioni sperimentale agrarie italiane, vol. 36, 1903, pp. 513–517.

GROHMANN, ——. Erfahrungen und Anschauungen ueber Rauchschaeden im Walde und deren Bekaempfung. (Experience with, and theories of, smoke injuries in forests and their prevention.) Berlin, 1910, 44 pp. Table of contents is as follows:

Introduction.
How do forest injuries by smoke take place?
Caustic injuries.
Resistance of various woods to this type of injury.
Importance of soil conditions.
Various diseases caused by acids in smoke.
Comparison of the two types of injury.
Conditions decreasing or increasing injury.
Of what importance are smoke injuries in forestry?
Preventive principles.
Conclusion.

HALDANE, J. S. The relation of sulphur in lighting gas to air vitiation. Jour. Gas Light, vol. 83, 1903, pp. 564–565. The ill effects resulting from the combustion of illuminating gas containing sulphur compounds are due to the formation of both sulphurous and sulphuric acids, both of which are injurious to health. Gases containing various amounts of sulphur were burned in rooms and the various effects on humans—closeness, acid taste, tendency to headache, sneezing, etc.—noted. With 40 grains of sulphur per 100 cubic feet of gas, a taste of sulphurous acid and slight irritation of the air passages were distinctly noticed at about 13 volumes of carbonic acid per 10,000. With only 9 or 10 grains of sulphur, on the other hand, similar irritation of the air passages was not noticed until the carbonic acid rose to about 35 or 40 volumes; and even at this point no acid taste could be detected—possibly because any sulphurous acid formed had been almost entirely oxidized to sulphuric acid. It was thus evident that the unpleasantness of the air varied in proportion to the amount of sulphuric and sulphurous acid present. With 51 grains of sulphur in the gas and 39 volumes of carbonic acid in the air, distinct fog was observed in the room, although no moisture had condensed on the windows, and the air was only 81 per cent saturated with moisture, as was shown by the readings of dry and wet bulb thermometers (23.5° and 21.5°). The air was extremely unpleasant. The fog was more evident when with the same gas burning and the air 82 per cent saturated with moisture, the carbonic acid had risen to 48 volumes. When the air contained about the same proportions of moisture and carbonic acid, with only the ordinary gas burning, no distinct fog could be seen. In one individual, sneezing was produced on going into room 1 with 35 volumes of carbonic acid in the air, and 36 grams of sulphur in the gas. Two others complained of slight headache after a few minutes.

HASELHOFF, E. Investigations on the action of sulphurous acid on soil. Zeitschr. f. Pflanzenkrankheiten und intern. phytopathalogischer Dienst, vol. 1, No. 3, 1908, pp. 73–91. Abstracted in Botanisch. Zentralbl., vol. 110, 1909, pp. 218–220 The first part of this work describes a continuation of previous investigations. SO_2 was introduced into the soil during the period of vegetation. The arrangement used was as follows: A funnel of such diameter that it fitted snugly into the flower pot was bent below the neck of the funnel and drawn out in such a way that it stuck out of the pot and in this way simplified the introduction of the SO_2. In the lower part of the funnel there was a glass plate, pierced with holes and covered with cotton to prevent the soil falling through. The previous conclusions were confirmed. The second part of the work is devoted to a discussion of the action of sulphurous acid on soil containing copper.

HASELHOFF, E. Memorial volume in commemoration of the 50th anniversary of the agricultural station at Marburg (Germany). Marburg, 1907, 93 pp. Contains Haselhoff's work on the action of sulphurous acid.

———. The action of sulphurous acid, zinc oxide, and zinc sulphate on soil and vegetation. Jahresber. der landwirtschaftlichen Versuchsstation, No. 4, 1903-4. States that the investigations were undertaken to determine the possible injuries to vegetation from the waste gases of a zinc smelter. For this purpose a series of tests was undertaken, in some of which the soil received an addition of lime; in the remainder the soil remained untreated. Sulphurous acid (as SO_2), ZnO, and $ZnSO_4$ were then added. Sulphurous acid in the soil is immediately oxidized to sulphuric acid. The H_2SO_4 content of the soil rose from 0.076 to 0.139 to 0.153 per cent. It may be concluded that a soil would not become barren on account of the action of SO_2 if there be sufficient bases present in the soil to combine with the sulphuric acid formed. Wheat was used for these experiments.

HASELHOFF, E. and GOESSEL, ——. The action of sulphurous acid, zinc oxide, and zinc sulphate on soil and vegetation. Zeitschr. f. Pflanzenkrankheiten, vol. 14, 1904, pp. 193-201. Abstracted in Botanisch. Zentralbl., vol. 96, 1904, p. 619. States that in the investigations restricted to a study of the effect of sulphurous acid, SO_2 was added directly to the soil. The soil was introduced into flower pots with a surface of 300 sq. cm., each pot containing 8.5 kg. of soil. Three pots were used in each series of experiments. In one series 10 grams of $CaCO_3$ was added to the pot. The procedure was as follows: 4 kg. of soil was taken from each of three pots, mixed, and the 12 kg. thus obtained introduced into a wooden box. Through this box there passed five connecting glass tubes, which, within the box, were perforated with many tiny holes, these serving for the distribution of SO_2 through the soil. The soil retained the SO_2 inasmuch as no odor of SO_2 could be detected. For liberating the SO_2 a mixture of three parts calcium sulphite and one part gypsum was decomposed by HCl. The soil was treated with gaseous SO_2 on two different days for three and two hours, respectively, after which all was thoroughly mixed and distributed among the three pots from which it had been taken. The next spring the treatment was repeated for two days of five hours each, after which corn was planted. The conclusions drawn follow: The sulphuric acid content of the soil is increased by the action of sulphurous acid. Vegetation is not injured if the soil contains sufficient bases (lime) to neutralize the acid. The sulphuric acid content of vegetation is proportional to the sulphuric acid content of the soil.

HASELHOFF, E., and LINDAU, G. Die Beschadigung der Vegetation durch Rauch (Injuries to vegetation by smoke). Leipzig, 1903, 412 pp.

HASENBAEUMER, ——, and OTHERS. Determination of injuries to vegetation by smoke gases. Paper read before Medizinische Naturwissenschaftliche Gesellschaft zu Muenster. Abstracted in Rauch und Staub, vol. 3, 1912, pp. 59-60.

HAYWOOD, J. K. Injury to vegetation by smelter fumes. U. S. Bureau of Chem., Dept. of Agriculture, Bull. 89, 1905. States that for the actual experimental work a cabinet 5 by 2 by 4 feet, with glass sides, was built, and this was so arranged that it could be lifted from its base for the introduction of plants. At the front was a door 1 foot square. The cabinet was practically air-tight. Carbon bisulphide was burned for the production of the sulphur dioxide, and the latter was distributed uniformly by means of an electric fan. The plants were fumigated for one hour and then thoroughly aired, receiving three to four successive treatments per day. With both pines and cowpeas positive results were obtained, injury being established with an increase in the sulphur trioxide content. An examination of the vegetation in the vicinity of the smelter at Redding, Cal., gave positive evidence of injuries due to sulphur dioxide. These injuries extended over an area at least 3½ miles north, 9 miles south, 2½ miles east, and five-sixths of a mile west of the smelter.

HAYWOOD, J. K. Injury to vegetation and animal life by smelter wastes. U. S. Bu. of Chem., Dept. of Agri., Bull. 113, 1908. The preliminary report on this work was published in Jour. Am. Chem. Soc., vol. 29, 1907, pp. 998–1009. Bulletin states that the experimental methods are the same as those described in Bulletin 89 of the Bureau of Chemistry. The conclusion is drawn that sulphur dioxide is injurious to the growth and development of trees and foliage. The results of the field experiments on smelter fumes are given in the abstract of the article referred to above.

——— Injury to vegetation and animal life by smelter fumes. Jour. Am. Chem. Soc., vol. 29, 1907, pp. 998–1009. Chem. Abs., vol. 1, p. 2870. Gives a brief review of the results published by the author in Bulletin 89 of the Bureau of Chemistry and discusses the investigation carried out at Ducktown, Tenn. The resistance of trees to the action of sulphur dioxide varied with the species. The injury was determined by means of the sulphur trioxide content. The vegetation around Ducktown was injured for at least 10½ miles north, 8 miles south, 5 to 5½ miles east, and 8½ miles west. The injury was probably more extensive, but could not be established from the chemical analyses. The same conclusions will probably be arrived at in an investigation now (at the time of article) being conducted in the vicinity of the smelter at Anaconda, Mont. This paper is a preliminary report on Bulletin 113 of the Bureau of Chemistry.

——— Injury to vegetation and animal life by smelter wastes. U. S. Bu. of Chem., Bull. 113 (revised), 1911. Chem. Abs., vol. 5, 1911, p. 1055. In addition to recapitulating all previous data, further analytical results on the injuries to trees are given.

——— Smelter smoke. Science, vol. 26, 1907, pp. 476–478. Chem. Abs., vol. 2, 1908, p. 255. The writer refutes some of the statements and conclusions expressed by Ebaugh in the Journal of the American Chemical Society, vol. 29, 1907, pp. 951–970.

HEDGCOCK, G. G. Injury by smelter smoke in southeastern Tennessee. Jour. Wash. Acad. Sci., vol. 4, Feb. 19, 1914, pp. 70–71.

——— Winter killing and smelter injury in the forests of Montana. Torreya, vol. 12, 1912, pp. 25–30. Discusses the physical differences in coniferous trees injured by frost and those injured by sulphur dioxide.

HERBIG, ——. Smoke damage from boiler fires. Zeitschr. angewandte Chem., vol. 22, 1909, p. 1882. Chem. Abs., vol. 4, 1910, p. 244. Gives method of determining SO_2 content of smoke and the atmosphere, as follows:

The air was sucked through a filter by means of a water suction pump so as to remove the soot, and then through a solution of iodine, a flask with iron filings and a gasometer. Three flasks placed behind each other and filled with iodine potassium iodide solution served for absorbing the sulphurous acid. The absorption was complete in spite of the rapid passage of the air (10 to 40 cubic meters per week). The sulphurous acid was determined as $BaSO_4$ after the iodine had been removed by evaporation over a spirit lamp. The flask filled with iron filings was for the purpose of holding back the iodine vapors passing over.

The volume percentage of SO_2 was obtained in the first place titrimetrically by using accurately prepared N/10 iodine solution, and secondly gravimetrically by absorption and oxidation of the SO_2 with sodium hypobromite. E. Rupp (Zeitschr. anal. Chem., 1906, p. 256) uses a solution for oxidizing (formic acid) which is obtained by the gradual addition of 30 grams of bromine to 30 grams of caustic soda dissolved in 900 c. c. water and diluting to a liter.

According to the equation $2NaOH+2Br=NaOBr+H_2O$, 60 grams of bromine is required for 30 grams of caustic soda.

In the volumetric determinations a 10-bulbed tube filled with standardized iodine was attached directly to the gasometer. For the absorption of the vaporized iodine carried along by the stream of gas four Volhard-Fresenius absorption flasks

filled with pure potassium iodide solution were also connected with the ten-bulb tube.

The velocity of the gas current could be only an average one so as not to bring about any loss of iodine, so that in passing through large quantities of smoke the duration of the experiment becomes exceedingly long, and in this way sources of errors may be formed.

For the gravimetric determinations with hypobromite and iodine solutions, two ten-bulb tubes placed behind one another were filled with 75 c. c. of bromine and iodine solution, respectively, diluted to 125 to 130 c. c., and these were connected with a Peligot tube filled with caustic soda solution.

The gravimetric method is the best that can be used. For this purpose 100 to 150 liters should be passed through a suitable absorption arrangement in a not too rapid stream.

KISSKALT, ——. The influence of the inhalation of sulphurous acid on the development of pulmonary tuberculosis. Zeitschr. f. Hygiene, vol. 48, 1904, pp. 269–279, states that the dogs chosen for the experiments were placed in a box 54 cm. square. Sulphurous acid was produced by the combustion of carbon bisulphid and was drawn through the chamber by means of a water pump. The gas was not produced in the experimental chamber itself. Behind the latter was a tube filled with soda lime, after which the air passed through a gasometer. With concentrations of 0.05 to 0.07 part per thousand, it was found that the resistance to pulmonary tuberculosis was diminished appreciably.

KNIGHT, ——, ROSE, —— AND CROCKER, ——. Effect of various gases and vapors on etiolated seedlings of the sweet pea. Paper read before botany section, American Association for the Advancement of Science, Boston, 1910. Science, vol. 31, 1910, pp. 635–636. Includes discussion of effects of sulphurous acid.

KOENIG, ——. Die Untersuchung landwirtschaftlich und gewerblich wichtiger Stoffe. (Examination of agriculturally and technically important materials.) Berlin, 1911. Gives methods of determining injuries to vegetation caused by smoke and dust.

KOENIG, ——, AND HASENBAEUMER.——. Influence of sulphurous acid on plants and fishes. Fuehling's Landwirtschaftliche Zeit., vol. 51, pp. 853–857, 893–895, 1902. Abstracted in Biedermann's Zentralbl. f. agrikultur Chem., vol. 32, 1903, p. 535, states that the investigations were undertaken to determine the injury caused by sulphurous acid when occurring in sulphite cellulose wastes. For this purpose, sulphurous acid, both free and in the form of calcium salts, was added to the feed water of both plants and fishes. Injurious action was apparent in both instances.

KOSMANN, ——. Sind Ringofengase der Vegetation schaedlich? (Are the gases from circular furnaces injurious to vegetation?) Verlag der Tonindustriezeit. 112 pp. 1903.

LEHMANN, ——. Recent investigations on the quantitative absorption of several poisonous gases by animals and men by means of the respiratory tract and its branches. Archiv f. Hygiene, 1908, vol. 67, pp. 57–98. In the case of sulphur dioxide, the experiments were made with rabbits and men. The amounts of gas in the air breathed by rabbits varied from 38 to 603 parts per million. The proportion of gas absorbed varied from 35 to 58 per cent, the larger figure being obtained with more dilute gas mixtures. The three experiments upon man were made with concentrations of 14 to 24 parts per million, and showed absorption of from 65 to 79 per cent of the sulphur dioxide that entered the lungs.

LINDAU, G. Recognition and prevention of injuries to vegetation by smoke. Gesundheits Ing., vol. 26, 1903, pp. 78–81; Mitteilungen aus der Praxis der Dampfkessel- und Dampfmaschinenwesen, vol. 26, pp. 793–795, gives short extract from Haselhoff and Lindau on the action of sulphur dioxide.

LINDAU, G. Die Beschädigung der Vegetation durch Rauch. Injuries to vegetation by smoke. Naturwissenschaftliche Wochenschrift, vol. 18, 1903, pp. 421–427. Short review of work of Haselhoff and Lindau.

LIPMAN, ——. Effect of smelter wastes on plant growth. Unpublished paper read before Southern California section of the American Chemical Society, May, 1914.

LOECKERMANN, ——. A new method for the prevention of injury to vegetation by smoke. Fuehling's Landwirtschaftliche Zeit., vol. 60, 1911, pp. 198–210. Deutsche Obstbau Zeit., 1911, pp. 67–69. States that in the past too much emphasis has been placed on the direct action of sulphurous acid and the injuries caused thereby. As a matter of fact, the indirect action—removal of lime from the soil—also plays an important part in the phenomena encountered. The article treats particularly of the work of Wieler, who proposes the addition of lime to the soil as a remedy for the injuries suffered.

MANN, ——. Damage caused by smoke. L'Horticulture Nouvelle, 1906.

MUELLER, E. Injuries to leaves and fruits of our fruit trees which have been sprayed with properly prepared copper solutions caused by the sulphurous acid smoke of factories, particularly because of heating with sulphur containing lignite and coal. Obstgarten, No. 11, 1903. Abstracted in Zeitschr. f. Pflanzenkrankheiten, vol. 14, 1904, pp. 288–289. States that sulphurous acid forms cupric hydrate on leaves that have been sprayed with copper solutions, and this is oxidized to soluble carbonate and finally sulphate, which has a caustic action on leaves, etc., destroying protoplasm and chlorophyll and thus causing spots, decolorization, desiccation, etc.

NASINI, ——, CUBONI, ——, AND MATTIROLO, ——. Chronic poisoning of fruit trees by factory smoke. Perizia giudiziaria, vol. 4, 1912, 82 pp., Bull. Bu. Agri. Intell. and Plant Diseases, vol. 3, p. 1045.; Chem. Abs., vol. 7, 1913, p. 1893. States that the gases issuing from the factory chimney contained 0.04 to 0.08 per cent SO_2, as more or less air was allowed to enter the furnaces. The leaves became yellow at the edges; a gradual discoloration of the chlorophyll granules occurred; the plasma became yellow; the injured leaves had a high sulphur content.

Relazione di perizia neli a causa sommaria di Garroni contro Societa anonima di lavorazione dei Carboni fossili e loro sotto prodotti. (Account of the suit of Garroni against the Societa anonima di lavorazione on injuries caused by smoke.) Torino, 83 pp. 1911.

NESTLER, ANTON. Urban factories and city air.

Sammlung von gemeinsamen Vortraege herausgegeben von dem Deutschen Verein zur Verbreitung gemeinsamer Kunst in Prague, 1905, Nos. 326–327, pp. 153–175.

NEUMANN, ——. Vegetation in the neighborhood of the Freiburg smelter.

Dritter Bericht des Vereins zum Schutze und zur Pflege der Alpenpflanzen, 1903, pp. 64–69.

OSTERHOUT, ——. On the effect of certain poisonous gases on plants.

University of California Publications. Section on Botany, vol. 3, No. 4, 1908, pp. 339–340.

Abstracted in Exp. Sta. Rec., vol. 20, p. 434. States that experiments were carried out to determine a method of distinguishing the effect of smelter fumes from that of drought and similar natural causes. This was accomplished.

RAMANN, EMIL. Über den Nachweis von Rauchschäden. (Determination of injuries caused by smoke.) Allgemeine Forst und Jagd Zeit., July, 1908, pp. 233–236. Abstracted in Zeitschr. f Pflanzenkrankheiten, vol. 19, 1909, pp. 346–347.

Opposes views of Gerlach (1907). In Gerlach's paper a method for determining the sulphur dioxide content of the atmosphere is given, together with a number

of characteristic signs of injury by smoke. Ramann objects to Gerlach's statement about the presence of insects in smoke-damaged forests. In the case of acute injury insects will shun such trees, but seek trees with chronic injuries. Chemical analyses of the needles will always be the basic method of identification of injuries and all other phenomena will always be subsidiary to this. The paper does not give any analytical data, but merely states that chemical analyses of the leaves and the presence of smoke constituents therein is the only incontrovertible proof of damage produced by smoke. It criticizes Gerlach's paper, which claims that the presence of certain insects and the dropping off of the pine needles are indications of injury by smoke. Ramann claims that such indications will not sustain a suit for damages in court, as these symptoms may be brought about by other conditions.

———. Waldbeschädigung durch Rauch. (Injuries to forests by smoke.) Zeitschr. f. Forst und Jagdw., January, 1908, pp. 32–35. States that injuries to evergreens in the vicinity of a mill were traced to sulphur dioxide from the chimney gases. The physical characteristics and SO_2 content of the needles are given. Pines were not injured, which proves only that the sensitiveness of various trees depends on local conditions.

RIPPERT, ——. Notes on the determination of smoke injuries in the Rhenish-Westphalian industrial district. Glückauf, vol. 48, 1912, p. 1993. Abstracted in Rauch und Staub, vol. 3, 1913, pp. 150–154; Feuerungstechnik, vol. 1, 1913, p. 168. Chemiker Zeit. Repertorium, 1913, p. 611.

States investigations were carried out in the vicinity of coal mines and coke ovens. Inasmuch as sulphur dioxide is the most injurious component of smoke, the study of that factor was emphasized. The experimental arrangement in the examination of the air was somewhat similar to that adopted by both Wieler and Gerlach. Only under exceptional conditions will the sulphur dioxide content of the air in the vicinity of such plants be high enough to cause appreciable injury. Injuries are caused not only by direct action on leaf parts, but also by action on the soil resulting in the removal of plant nutriments. A critical discussion is given of the various methods of establishing injuries by sulphur dioxide. Wislicenus (Zeitschr. angew. Chem., 1901, p. 689) as a result of his investigations comes to the conclusion that the limit of injury lies at an acid content of the air of 1:500000. Wieler (Untersuchungen ueber die Einwirkung schwefliger Saeure auf Pflanzen, p. 357) arrived at the same limits in his investigations. This limit, however, is true of plants most sensitive to smoke, of the coniferous woods, which, according to the investigations of Wislicenus, are injured only if their exposed organs are subjected to an atmosphere which contains 1 part of SO_2 in 500,000 parts of air during the entire period of development. Agricultural plants are much more resistant as Wieler's investigations have shown. The spores of grains, and young sprouts can, therefore, be subjected to an atmosphere with very high acid content without suffering injury. Thus, for example, wheat and rye plants were not injured when exposed to an acid atmosphere of 1 to 50,000. In experiments with beans, which are very resistant, the following results were obtained:

Results of experiments.

Period of experiment.	Ratio of SO_2 to air.		Action on vegetation.
	At beginning.	At end.	
Hours.			
6½	1:256000	.....	Uninjured.
8¾	1:471700	1:165000	Do.
5¼	1:117500	1:138000	Do.
6½	1:82300	1:87500	Do.
10	1:108000	1:130000	Slight injuries.
9	1:27000	.....	Pronounced spots.
9	1:76000	1:96000	Doubtful.
8½	1:218000	1:411000	Uninjured.
9	1:147000	1:227000	Do.
7½	1:116000	1:180000	Do.

Experiments of Wieler with forest trees show that pines and beeches are especially sensitive whereas oaks possess a higher resistance. An acid content of 1:52000 produces no visible injuries in the case of oaks, but results in an unfavorable action on assimilation. More sensitive kinds of wood, for example, beeches, manifest an appreciable retardation of the process of assimilation even with a ratio of acid to air of 1:300000.

RONZANI, ——. The influence of the respiration of caustic gases on the resistance to infectious diseases. Archiv f. Hygiene, vol. 67, 1908, pp. 287–366.

In investigating this problem Ronzani restricted himself to the action of chlorine sulphur dioxide, and nitrous oxid. His general conclusion is that prolonged breathing of noxious vapors, which in the case of chlorine, sulphur dioxide, and nitrous acid exceed the proportions of 0.002, 0.05, and 0.05 parts per parts of air, respectively, occasion in animals. (*a*) A gradual decrease in nutrition and a variation of the chief blood components; (*b*) a decrease in the production of specific antibodies and a lowering of the bactericidal strength of the lungs; (*c*) in the case of receptive animals a lowering of the power of resistance to infection; (*d*) in immune animals, receptivity for infection. Dogs, guinea pigs, and pigeons were used in the experiments. The methods were elaborate and carefully worked out. They may be summed up by saying that the animals were subjected to the vapors in question in wooden chambers with metal floors and after inhaling the gas for definite periods the following determinations were made: (1) The agglutinizing power of animals immunized against certain infections (typhoid, pneumococcus, haemolytic anthrax, tuberculosis); (2) the immunizing power of the blood serum of both the treated animals and control animals; (3) the bactericidal power of the lungs; (4) resistance of receptive animals to inoculation with virulent pathogenic germs; (5) resistance of receptive animals to inoculation with weakened pathogenic germs; (6) resistance of immune animals to inoculation with virulent pathogenic germs.

RUSTON, —— Air pollution by coal smoke and its effects on vegetation. Paper read at the Smoke Abatement Conferences, March, 1912. Trans., pp. 33–45. Abstracted in Jour. Roy. Sanitary Inst., vol. 33, pp. 433–435. This paper is practically a reprint of Crowther and Ruston, Jour. Agr. Sci., vol. 4, p. 25.

—— Influence of smoke on plant growth. Read before Manchester and Salford Smoke Abatement Exhibition and Conference. Report of the Smoke Abatement League, 1911, pp. 44–53; Rauch und Staub, vol. 2, pp. 93–98; abstracted in Chem. Trade Jour., vol. 49, p. 522; Chem. Abs., vol. 6, 1912, p. 419. States that smoke has a harmful action on vegetation, owing to both the soot and the acid components. To determine the effect of the free acids (sulphur dioxide) a

series of experiments on grass was undertaken. In these a number of grass test plats were grown under similar conditions, except for the rain water with which they were watered. In one series the plats were watered with neutralized rain water; in another with unneutralized, and in a third with unneutralized rain water from a district high in sulphur dioxide smoke content. The growth and life of the grass as well as its food value were unfavorably influenced by the SO_2. This factor in smoke also retards the growth of trees and inhibits the activity of soil bacteria, particularly the nitrifying organisms. The acidity of the waters used was as follows:

Data regarding water used in experiments.

Source.	Suspended matter.	Acidity.
	Pounds per acre.	*Pounds per acre.*
Hunslet	1,565	90
Leeds University	399	26
Headingley Hill	273	18.5
Weetwood Lane	147	11
Roundhay	90	None.

"It has been observed in Leeds that ash trees in those parts of the town with purer air often keep their leaves four and even six weeks longer than trees in parts of the city with worse air. For example, in the fall of 1908 it was established that in Roundhay where the air contains 90 pounds of suspended matter per acre, but on the other hand no acid, ash trees bore their full quota of leaves even as late as the 17th of November. At the same time, however, it was observed that in Weetwood Lane, where the air precipitates 147 pounds of suspended matter and 11 pounds of sulphuric acid per acre, all leaves had fallen off long before the end of October, and that only few trees carried any foliage on October 22. In Kirkstall, where 352 pounds of suspended matter and 8 pounds of sulphuric acid per acre were established, only one ash could be found on October 5 that carried foliage, and in Headingley, with 659 pounds of suspended matter and 11 pounds of acid per acre, all the leaves had fallen off from the ashes by this time. In Hunslet, where 1,565 pounds of suspended matter and 90 pounds of sulphuric acid are precipitated per acre, the leaves were removed from all ashes by September 18, while at the same time all the ashes in Roundhay bore foliage up to the beginning of November."

SABACHNIKOFF, ——. Action of sulphurous acid on pollen. Compt. rend. Soc. biologique, vol. 72, 1912, pp. 191–193; Chem. Abs., vol. 6, p. 1305. States that the flowering plants were placed under a bell jar containing a known mixture of air and sulphur dioxide. After the plants had been subjected to the action of the gas, the pollen was removed and allowed to germinate in incubators, solutions of saccharose being used as the culture medium. This air was saturated with water vapor, germination taking place at 25° under the influence of diffused light. The concentrations employed varied from 1:1000 to 1:300000, action lasting 3 to 48 hours. It was concluded that a concentration of 1 to 48000 acting for 48 hours is without effect, but that concentrations higher than 1 to 13000 destroy the germinating power if allowed to act for 3 hours. Poisoned pollen which is not killed develop abnormally.

SCHAEFER, ——. Contamination of the air of our cities with sulphur dioxide the cause of respiratory disease. Boston Med. and Surg. Jour., vol. 157, 1907, pp.106–110. Gives a fair review of the subject, but does not contain any original work. Experimental data quoted.

SCHROETER, E. Die Rauchquellen im Koenigreich Sachsen und ihre Einfluss auf die Forstwirtschaft. (The sources of smoke in the Kingdom of Saxony and their effect on forestry), Berlin, 220 pp. The table of contents is as follows:

I. Introduction. II. Methods of procedure (information obtained by circulars, etc.). III. Causes and effects of smoke damage—Sources of smoke in general; action of waste gases; chronic and acute injuries; coefficients of injury of typical industries; special action of sulphur dioxide; consequences in pine forests. IV. Smoke injuries in forests of Saxony and their sources. V. Preventative and curative methods. VI. Necessity of public regulations. VII. Conclusions. VIII. Supplement. (Maps, charts, tables, etc.)

SEIDELL, —— and MESERVE, ——. Gaseous impurities in the air of railway tunnels. Bull. 92, Hygienic Laboratory, United States Public Health Service, June, 1914. Contains a method for determining the sulphur dioxide content of atmosphere.

SOMMA, ——. Determination of the action of noxious gases on vegetation. Yearbook Tech. and Nav. Inst. at Bari (Italy), 1904.

SORAUER, PAUL. Die mikroskopische Analyse rauchbeschaedigter Pflanzen. (Microscopic analysis of smoke-injured plants.) Berlin, 1911. 58 pp.

——— Handbuch der Pflanzenkrankheiten. (Manual of Plant Diseases.) Third edition, in three volumes, Berlin, 1909–1911. Volume I treats of nonparasitic diseases, including those caused by sulphurous acid. See pp. 711–747.

——— Note on the anatomical analysis of plants injured by smoke. Landwirtschaftliche Jahrbuecher, vol. 33, 1904, pp. 585–664. Is restricted to a discussion of injuries caused by hydrochloric acid but with the article under the same title by the same author published in 1908 gives the complete method.

——— Notes on the anatomical analysis of smoke-injured plants. Landwirtschaftliche Jahrbuecher, vol. 37, 1908, pp. 673–710. Abstracted in Botanisch. Zentralbl., vol. 110, 1909, pp. 354–357. States that the work is a continuation of that reported in volume 33 of the Landwirtschaftliche Jahrbuecher (1904). The previous investigations were extended to the study of injuries to pines caused by smoke, among other factors being the influence of sulphur dioxide. The entire work presents a microscopical method for determining the specific causes of any injury suffered in any given instance. The proposed method is discussed in detail and is considered of great value as a supplement to chemical analysis.

STUTZER, ALBERT. Action of sulphurous acid upon plants. Deutsche landwirtschaftliche Presse, vol. 29, 1902, p. 725. Abstracted in Chem. Zeit. Repertorium, 1902, p. 327; Jour. Soc. Chem. Ind., vol. 22, 1902, p. 42. Treats of use of sulphur dioxide in aqueous solution for the purpose of investigating the injuries which might accrue from sulphite cellulose waste liquors.

TATLOCK, ——, and THOMPSON, ——. Damage to vegetation by sulphurous and sulphuric acids in the atmosphere. Analyst, vol. 39, 1914, pp. 203–210; abstracted in Jour. Soc. Chem. Ind., vol. 33, 1914, p. 610; Chem. Abs., vol. 8, p. 2559. States that in cases of injury to vegetation too much emphasis must not be placed on the sulphuric acid content of the injured plants. Analytical data on such plants are given.

VON RUŠNOV, PETER. Über die Festellung von Rauchschäden im Nadelwald (Effects of factory smoke on pine forests). Zentralbl. gasammte Forstwesen, vol. 36, June, 1910, pp. 257–268; Chem. Abs., vol. 5, 1911, p. 897; Experiment Station Record, vol. 23, p. 726. Calls attention to the serious damage to coniferous forests that occurs from factory smoke containing sulphur dioxide and sulphur trioxide. Various examples are cited, and the character and extent of the injuries, the age and kind of trees affected, the results of microscopic examinations, and chemical analyses of the injured trees are given.

VON RUŠNOV, PETER. The establishment of injuries by smoke in pine forests. Zentralbl. gesammte Forstwesen, 1910, pp. 310–330. Abstracted in Botanisch. Zentralbl., vol. 117, 1911, p. 487. States that the sulphuric acid content of the needles compared to that of healthy examples in the same locality is admirably suited for establishing the source of injury. The SO_2 content of healthy pine needles, for example, was 0.19–0.22 per cent, whereas those injured by smoke contained as much as 1.27 per cent.

WEIGEL, ——. A case of croupous pneumonia after breathing sulphur dioxide. Muenchner medizinische Wochenschrift, 1903, p. 1236. Gives the history of the case of a workman who inhaled concentrated sulphur dioxide fumes and died from croupous pneumonia within seven days. Small concentrations have an injurious effect. No definite figures are given. "The workman was engaged in sulphurizing hops. During this there was an excessive development of sulphur dioxide to which this workman was particularly exposed because he tried to empty the pan filled with an excessive amount of burning sulphur."

WERNER, ——. Smoke injuries. Oesterreich. Vierteljahrschrift f. Forstwesen, vol. 26, 1908, pp. 107–121.

WIDTSOE, J. A. Smelter smoke and agriculture. Bull. 88, Utah Agri. Coll. Exp. Sta., 1903. Little experimental work discussed. States that injuries from smelter fumes have been much exaggerated, and that fodder exposed to fumes is not injurious to cattle.

WIELER, A. Über unsichtbare Rauchschäden (Invisible smoke injuries). Zeitschr. f. Forst u. Jagdw., vol. 35, April, 1903, pp. 204–205. Abstracted in Zeitschr. f. Pflanzenkrankheiten, vol. 14, 1904, pp. 84–85. Author states that by invisible injuries are meant injuries that are not manifested to the naked eye by the destruction of leaf parts, the injuries being caused by the action of acid gases, chiefly sulphur dioxide, and result in decreased production of organic matter by lessening the assimilation of carbonic acid. In a direct experiment in a Wislicenus smokehouse in which carbon bisulphide was burned to sulphur dioxide, it was shown that with a concentration of 1 : 500,000 decoloration of the leaves of beeches takes place. Upon exposure to sunlight both change of color and death of many leaf parts soon became manifest. The effects on various other trees were also given.

——— Über unsichtbare Rauchschäden bei Nadelbäumen (Invisible smoke injuries to pine trees). Zeitsch. f. Forst u. Jagdw., vol. 29, September, 1897, pp. 512–529.

———. Casual relationships between injuries to vegetation and the products of combustion of coal. Rauch und Staub, vol. 1, 1911, pp. 248–255. States that in the past too much emphasis has been placed on the injuries caused by the presence of sulphur dioxide in the atmosphere. The results of Wieler's investigations would make it appear that the chief mode of action is the removal of lime from the soil by the sulphuric acid resulting from the oxidation of precipitated sulphur dioxide.

———. Indirect action on vegetation of smelter fumes and other acid gases. Address before Naturwissenschaftliche Gesellschaft zu Aachen, June, 1910. Author's abstract in Deutsche landwirtschaftliche Presse, vol. 37, pp. 871–872. Abstracted in Fuehling's landwirtschaftliche Zeit., vol. 60, p. 204. Brings forward new experimental proof of the author's theory that sulphur dioxide causes indirect damage by removing lime from the soil. In establishing sulphur dioxide injuries too much emphasis should not be placed on the sulphuric acid content of the plants in question.

———. Litigation on smoke injuries. Jahresbericht der Vereinigung der Vertreter der angewandten Botanik, vol. 6, 1908, pp. 47–72. Gives further experimental evidence in support of the author's theory of the removal of lime from soil exposed to sulphur dioxide.

WIELER, A. Litigation on the injuries caused by smoke. Jahresbericht der Vereinigung der Vertreter der angewandten Botanik. Abstracted in Zeitschr. f. Pflanzenkrankheiten, vol. 21, 1911, pp. 168–169. Gives new experimental evidence in support of the author's views on the action of sulphurous acid on soils.

——— Pflanzenwachstum und Kalkmangel im Boden. Untersuchungen ueber den Einfluss der Entkalkung des Bodens durch Huettenrauch und ueber die giftige Wirkung von Metallverbindungen auf das Pflanzenwachstum. (Plant growth and deficiency in lime in the soil. Investigations on the influence of removal of lime from the soil by smelter fumes and on the poisonous action of metallic compounds on plant growth.) Berlin, 1912, 237 pp. This is a continuation of the author's "Untersuchungen ueber die Einwirkungen schwefliger Saeure auf Pflanzen" published in 1905.

———. Recent work on the influence of acid gas on plants. Jahresbericht der Vereinigung der Vertreter der angewandten Botanik, vol. 3, 1904–1905, pp. 166–178. Abstracted in Botanisch. Zentralbl., vol. 105, 1907, pp. 109–111. Gives a critical review of the literature from 1903 to 1905, including author's own book, placing special emphasis on the effects of sulphur dioxide.

———. Smoke injuries which have received but little attention. Jahresber. der Vereinigung der Vertreter der angew. Botanik, 1903, pp. 62–78. Abstracted in Biedermann's Zentralbl. f. Agrikulturchemie, vol. 34, 1905, pp. 248–250; Botanisch. Zentralbl., vol. 95, 1904, p. 304. Author takes exception to the generally accepted view that sulphurous acid when injuring vegetation acts only on the leaves of the trees. There seems to be a definite action on the soil caused chiefly by acid precipitated by rain. In order to prove that the destruction of the green color of the leaves of beech trees, and the fact that they turn red are both due to sulphur dioxide, two beeches were grown in a smoking chamber (volume 7 cubic meters) which contained dilute sulphurous acid produced by the combustion of carbon bisulphide with alcohol. Fumigation took place from May 31 to July 10, and caused partial bleaching of the leaves. Upon exposure to sunlight, however, the leaves turned reddish-brown, several dying.

———. The action of acid smoke gases on vegetation and soil. Address delivered at May, 1913, meeting of Naturhistorischer Verein der preussischen Rheinlande und Westfalens und Niederrheinisch Geologischen Vereins. Abstracted in Glueckauf, 1913, p. 836; Rauch und Staub, vol. 3, p. 366.

———. The action of sulphurous acid on plants. Berichte deutsch. botanisch. Gesell., vol. 20, 1902, pp. 556–566. Abstracted in Botanisch. Zentralbl., vol. 92, 1903, p. 205; Zeitschr. f. Pflanzenkrankheiten, vol. 14, 1904, pp. 83–84. The top of the plant under examination passed through a horizontal ground glass plate with a hole 6 to 7 cm. in diameter. Over the plant was placed a stoppered bell jar of a capacity of about 27 liters, which fitted snugly on the glass plate. The rubber stopper of the bell jar was three-holed. Through one hole passed a mercury manometer, and the two other holes served for the introduction and removal of the gas. The air passed through a gasometer, and after absorption of both carbonic acid and the water vapor it was led into a flask containing sulphuric acid and was then saturated with carbonic acid by means of dripping soda solution. From here the air passed into a small container with H_2SO_4 where it became saturated with sulphurous acid by means of dripping Na_2SO_3. After passing through a mixer it passed into the bell jar from the top and was drwan out at the bottom. After leaving the bell the air passed through a worm or worms filled with standard $Ba(OH)_2$. The source of light was electricity. Experiments were also conducted with strong incandescent burners. The electric light, however, gave greater assimilation values. The air contained 0.1 of volatile CO_2. The experiment lasted 5 to 6 hours. Under the influence of SO_2, assimilation was decreased, but different plants, even of the same species, were of different sensitiveness. Dilute

concentrations were used. In addition, beeches were subjected to SO_2 fumes in a glass smokehouse. The concentration was 1:500000, but during part of the experiments the concentration was higher because of a defect in the lamp burning the CS_2. Plants were kept in this for about six weeks and then eight days after the lamp had been extinguished. The plants were then taken out and submitted to the action of sunlight. The leaves had changed slightly because of being kept in the smokehouse. After being in sunlight for a few days, the injuries became manifest, parts dying off and turning yellow.

WIELER, A. The importance of air analysis in smoke litigation. Jahresbericht der Vereinigung der Vertreter der angewandten Botanik, vol. 4, 1906, pp. 63–78. Gives a method for determining the sulphur-dioxide content of the atmosphere. "By means of an aspirator the accurately measured volume of air is drawn through the absorbing solution. For this purpose a solution of potassium carbonate was used."

———. The literature of smoke injuries of recent years. Jahresber. Verein. der Vertreter der angew. Botanik, vol. 6, 1909, pp. 73–102. Reviews various articles of the preceding year.

———. The removal of lime from soils through smelter smoke. Wiener landwirtschaftliche Zeit., vol. 63, 1913, p. 135; Chem. Abstracts, vol. 7, p. 1779. States that experiments conducted in the vicinity of the smelters at Claustal show that the damage from smelter fumes is of two kinds: (1) Injury to the leaves, and (2) removal of $CaCO_3$ from the soil.

———. Untersuchungen ueber die Einwirkung schwefliger Saeure auf die Pflanzen. (Investigations on the action of sulphurous acid on vegetation.) Berlin, 1905, 427 pp. This work includes a survey of past work and presents the results of much original investigation.

WINKLER, ——. Vortraege und Abhandlungen ueber Abgase und Rauchschaeden. (Addresses and articles on waste gases and smoke injuries.) Berlin, 1913, 90 pp.

WISLICENUS, H. Die Grundlagen technischer und gesetzlicher Massnahmen gegen Rauchschaeden. (Principles of technical and legal measures against smoke damage.) Berlin, 1908, 80 pp. Reviews the problem, giving the limits of injury and the various means of prevention.

——— Experimental smoke damage in the experimental smokehouse at Tharandt. Report of the 57th Congress of the Saxony Forestry Society. Trans., 1913, pp. 78–93. Abstracted in Chem. Zentralbl., No. 1, 1914, p. 1897. The experiments were carried out with both sulphur dioxide and silicon fluoride. The former showed that the present limits of concentration (1 : 500000) are too low. Sulphur dioxide affects assimilation. According to the experiments of the author, a cessation of assimilation by removal of light makes the plant entirely unsusceptible to the action of SO_2 in the daytime, even in summer.

——— Ueber die Abgasfrage und ihre Bekaempfung. (Waste gases and their prevention.) Dresden, 1911.

PUBLICATIONS ON MINERAL TECHNOLOGY.

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